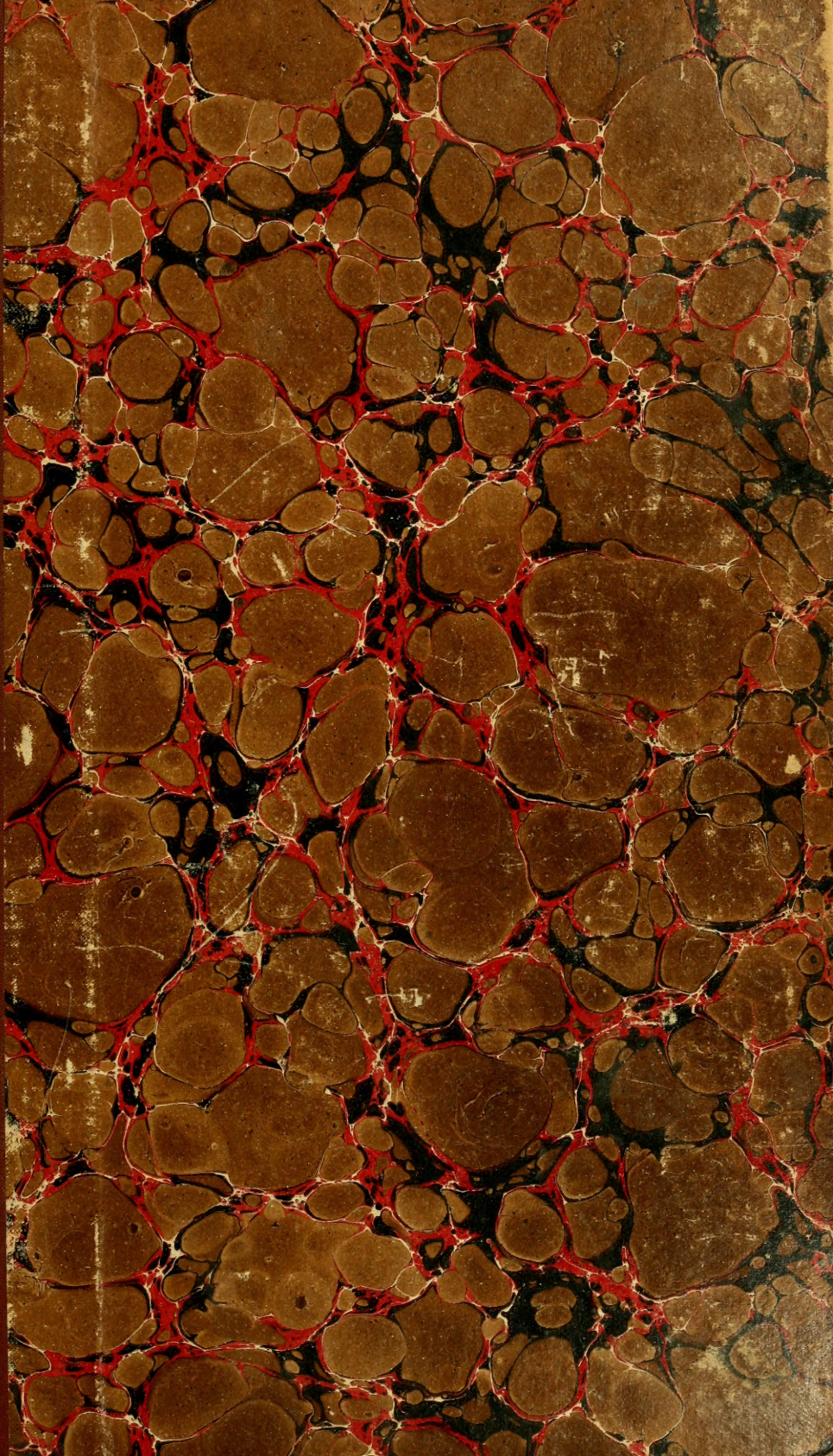

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TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

October 3, 1887.

REGULAR BUSINESS MEETING.

Vice-President, PROF. W. P. TROWBRIDGE, in the chair.

Twenty-one persons present.

The SECRETARY presented to the Library of the Academy a scrap-book filled with matter relating to the meeting of the *American Association for the Advancement of Science*, held in New York in August.

PROF. D. S. MARTIN made a statement, in reply to inquiry, concerning the proposed monument to J. J. AUDUBON, which matter was broached at the special meeting of the Academy held August 15th. A motion was presented to appoint a committee to solicit and receive subscriptions for a monument to be erected over the remains of Audubon in Trinity Cemetery. The motion being adopted, the Chair appointed as such committee PROF. THOMAS EGLESTON, PROF. D. S. MARTIN, and DR. N. L. BRITTON.

The Chair read an announcement of the death of SPENCER FULLERTON BAIRD, an Honorary Member of the Academy, and spoke, from personal acquaintance, of the noble qualities of

the deceased, and of the importance and self-sacrificing character of his work.

MR. S. W. FORD presented a paper:[1]

NOTES ON CERTAIN FOSSILS DISCOVERED WITHIN THE CITY LIMITS OF QUEBEC.

On the 16th of July, 1885, the writer received by registered post from Alfred R. C. Selwyn, Director of the Geological Survey of Canada, a small collection of fossils obtained by Mr. T. C. Weston on the 24th of June of that year, from the strata at or near St. John's Market, Quebec. The letter accompanying the specimens appears to have miscarried, or, at least, did not reach me; but after studying the fossils for several days, I returned them, at the same time addressing a letter to Dr. Selwyn, containing a brief expression of the conclusions at which I had arrived concerning them. Among the notes which I made at that time in relation to these fossils, I find the following:

"The box from Dr. Selwyn contained four (4) pieces of lime-stone. I find upon these the following species:

"1. Two specimens of the glabella of *Remopleurides* (?) *Schlotheimi* Bill., but much smaller than the examples figured by Billings. Also a portion of a free-check, probably of this species.

"2. One specimen of a *Shumardia* near to, if not identical with *S. granulosa* Bill. (Head).

"3. Portion of the thorax (consisting of seven segments) of a species of *Harpides*—the species not determined.

"4. Two specimens of the pygidium of a Trilobite probably identical with *Bathyurus caudatus* Bill., but much smaller.

"5. Numerous specimens of a small *Lingula*, most probably the young of *Lingula Quebecensis* Bill.

"6. Numerous specimens of a small *Leptæna* or *Strophomena*, apparently undescribed.

"7. Several specimens of a species of *Graptolithus*, probably the *Graptolithus* (*D.*) *pristiniformis* of Hall.

"8. Portion of the plate of a Cystidean (?).

"I consider the above species to be certainly 'Quebec;' but it is very remarkable that, in the case of the species *Remopleurides* (?) *Schlotheimi*, *Bathyurus caudatus*, and *Lingula Quebecensis*, the forms should be so much smaller than the typical

[1] This paper was read, in the absence of the author, by Prof. D. S. Martin.

examples figured by Billings. The *Harpides* is also a diminutive species, judging from the fragment we have of it."

The specific conclusion to which I was led from the study of the above-mentioned fossils was that they represented the "Levis" formation of the Canadian geologists, although admitting the possibility that they might be found, on further investigation, to mark a new or distinct division of that formation; and this conclusion I communicated to Dr. Selwyn.

In a highly interesting and important paper, entitled "*Preliminary Report on some Graptolites from the Lower Palæozoic Rocks on the South Side of the St. Lawrence from Cape Rossier to Tartigo River, from the North Shore of the Island of Orleans, One Mile above Cape Rouge, and from the Cove Fields, Quebec,*" published in the "Transactions of the Royal Society of Canada for 1886," Prof. Charles Lapworth, to whom the graptolitic species from the several localities named were submitted, at the request of Dr. Selwyn, for identification and study, has reported upon the graptolites collected at St. John's Market, Quebec, but makes no mention of the occurrence at that locality of any of the other species already spoken of in this paper. It would appear from this that he was not aware of the occurrence there of the Trilobites, Brachiopods, etc., submitted to me by Dr. Selwyn; and this view is sustained by the fact that, on page 6 of his Report, he says: "There is nothing in the Cove Fields and St. John's Market fauna that reminds us in the slightest degree of the fauna of Point Levis. The fossils are the fossils of the Marsouin River fauna [*i. e.*, according to Professor Lapworth, a fauna 'Trentonian' in character, under which designation he would also include the Norman's Kill fauna] or second Ordovician [*i. e.*, Lower Silurian] fauna, and have not a species in common with the first Ordovician fauna, the typical fauna of the rocks of Point Levis." And further, on page 9: "The so-called Quebec rocks, of the town of Quebec, as typified by the fossils forwarded from the localities of the Cove Fields and St. John's Market, are not of Quebec age at all. They are probably the newest rocks represented in the collection, and possibly shade upwards from the Marsouin Graptolitic shales of Orleans Island and Cape Rouge. They appear, however, to be of greater antiquity than the Utica slates of Lake St. John, answering to the basement zone of the British Bala, instead of to the middle zone, which seems to be the place of the St. John shales."

The only species cited by Prof. Lapworth from the St. John's market locality, are *Diplograptus rugosus?* Emmons and *D. foliaceus?* Murchison, and both of these, it will be observed, are only provisionally identified. If the horizon of these species

is the same with that of the Trilobites and Brachiopods submitted to me by Dr. Selwyn, I think Professor Lapworth would be far from warranted in asserting that there is nothing in the St. John's Market fauna that reminds us, in the slightest degree, of the fauna of Point Levis, and I should expect his identifications of the two graptolitic species just cited to prove incorrect. Moreover, the Cove Fields and St. John's Market faunæ, looking at the graptolites of these faunæ alone, would appear to be different, since none of the species from these two localities have thus far been shown to be identical.

With respect to the stratigraphical position of the Norman's Kill graptolitic slates (which Professor Lapworth thinks have been referred with scarcely a shadow of palæontological evidence to the Lorraine or Hudson River group) in the Lower Silurian, many interesting facts having a bearing upon this question, that have come under the writer's observation during the past eighteen years, might here be mentioned; but I shall limit myself in the present paper to the presentation of the following: In the vicinity of Schodack Landing, and at several other points in the northwestern portion of Columbia and the southwestern portion of Rensselaer counties, New York, the Norman's Kill graptolitic zone, here about fifteen feet in thickness, is excellently exposed; and has yielded, in addition to fifteen of the Norman's Kill species, a small Lingula, and a Lamellibranch probably identical with the *Lyrodesma pulchella* of Hall (Pal. N. Y., vol. 1, p. 302, pl. 82, Fig. 12). The stratigraphical position of this zone, judging from several good exposures which I have studied in Rensselaer and Columbia counties, is at the summit of several hundred feet of soft olive shales, and at the base of a series of heavy-bedded grits or sandstones, which I am disposed to look upon as the equivalents, respectively, of the Lorraine shales and sandstones of northern New York. The gritty beds in question have yielded specimens of *Orthis testudinaria* and *Leptæna sericea*, and in the Poughkeepsie Lorraine grits these are often the only species present. Moreover, the slates of the locality whence the *Lyrodesma pulchella* was originally obtained (Cohoes Falls), abound in specimens of *Trinucleus concentricus*. A band of graptolitic slates, which I consider probably identical with that of Norman's Kill, also occurs opposite Albany, at a point known as Greenbush Heights; although the rocks at this point are much altered, and none of the species which they have afforded have been certainly identified. Three-quarters of a mile east of the last-mentioned locality, slates similar to those of Greenbush Heights are again exposed, and form the greater portion of a quite prominent elevation known as "Cantonment Hill." The slates of this hill (regarded as "Taconic" by Dr.

Emmons) are almost certainly of the same age with those of Greenbush Heights, *i. e.*, probably Lorraine; although the Utica formation may also here be represented. The hill itself has, undoubtedly, a synclinal structure, but this fact appears not to have been recognized by those who earlier studied it. Over a considerable portion of its eastern slope there is a deposit of limestone (regarded by Emmons as an outlier of the Calciferous Sandrock resting unconformably upon his "Taconic slate") which extends to and forms the summit of the elevation. This limestone is clearly of Trenton age, and has yielded a large number of Trenton species. The facts presented at this interesting locality appear to me strongly to favor the view that the Norman's Kill graptolitic slates are newer than the Trenton limestone. From twelve to fifteen miles further south (in the Schodack and adjacent regions) there are other Trenton exposures, some of which I was at first led to regard as constituting an integral portion of the Lorraine formation, but which I now think are demonstrably not such, involved in the folds which have there profoundly affected the gritty and slaty rocks, including the Norman's Kill graptolite-bearing beds already spoken of. The facts learned in eastern New York appear to me to demonstrate very effectually that the Norman's Kill graptolite beds are entirely independent of the Trenton formation.

In preparing this brief paper, I have been fully conscious of the fact that, inasmuch as Prof. Lapworth's report herein referred to is only a preliminary one relating to a very vexed subject, any criticism of his views upon doubtful points should be marked by the most respectful moderation, and governed by a thorough appreciation of the difficulties with which, in his studies of the American forms submitted to him for identification, he has had to deal.

The strata affording the St. John's Market fossils submitted to me by Dr. Selwyn, were placed by Sir Wm. Logan in the Quebec group; but from later examinations Dr. Selwyn was led to refer them to the Lorraine or Hudson River group. The list of species given at the outset of this paper appears to the writer to show, as already indicated, that Logan was right. It is earnestly to be hoped that, if this has not already been done, these species will also be brought to the notice of the learned English professor, in order that all of the evidence may be considered by him in reaching a final decision upon this important question.

Mr. George F. Kunz exhibited a mass of meteoric iron from Chattooga Co., Georgia.

Remarks were offered by MR. W. E. HIDDEN.

MR. WM. EARL HIDDEN made a formal announcement of the discovery by himself of a new twinning law in the crystals of the mineral Zircon. He stated that it had been his privilege to announce, in 1881 (*Am. Jour. Sci.*, xxi., 507), the first twins of zircons known, and to describe the law of their twinning (= 1-i), and that chance had thrown in his way yet another example of a second twinning belonging to this species. The new forms came from near Green River, Henderson Co., N. C., and exhibit twinning parallel to the pyramid 2 (2-2-1) of the first order. Careful measurements gave a very close approximation to the required angle for this new geniculation, close enough to insure the two specimens thus far discovered to be more than accidental formations. The prisms are perfectly parallel and the pyramids lie in the same zone of reflection. As associated minerals there were identified Epidote, Quartz, Allanite, a hydrated Titanite (Xanthitane) and Vermiculite. Mr. Hidden remarked that the near future would witness the mining of zircons by the ton, and the application of zirconia and zirconium compounds to the purpose of incandescent illumination under the Welsbach patent. A diagram of the manner of twinning was put on the blackboard by Mr. Hidden.

MR. GEORGE F. KUNZ stated that, in the last number of the *Mineralogical Magazine*, Professor Lazarus Fletcher had announced the very interesting fact that he had obtained cubes of a new distinct form of graphite, which he had named Cliftonite, and which had a hardness of 2.06, was cubic in form, with modifications of the tetrahexahedron. This is of especial interest from the fact that this form is peculiar to the diamond, and it suggests that perhaps the carbon in the Dunegan meteorite, from which he obtained it, may perhaps have been in a condition when it could have formed the diamond, but instead, this new form of carbon was produced.

The following paper was read by title:

A LIST OF PLANTS COLLECTED BY MISS MARY B. CROFT, 1884–'85, AT SAN DIEGO, TEXAS, NEAR THE HEADWATERS OF THE RIO DULCE, BY N. L. BRITTON AND H. H. RUSBY.

The species here enumerated were collected by Miss Croft during the years 1884–1886 and sent to Dr. Rusby for determination. His absence in South America has prevented their examination until the present time.

RANUNCULACEÆ.

19. *Anemone decapetala*, L., var. HETEROPHYLLA (Nutt.) (*A. heterophylla*, Nutt., mss.; Wood). We are unable to find any characters which would entitle this plant to specific rank. Indeed, our specimens show every gradation in leaf-form from the linear lobes of the typical *A. decapetala* to the nearly entire ones of the variety. A specimen collected by Merrill, in Robertson Co., Texas,[1] has both forms on the same plant. As here recognized, the variety extends east into Alabama (Buckley) and occurs also in South America, Cuming's specimens from Valparaiso in Herb. Torrey consisting of both type and variety.

BERBERIDACEÆ.

87. *Berberis trifoliata*, Moric.

PAPAVERACEÆ.

98. *Argemone Mexicana*, L.

CRUCIFERÆ.

88. *Vesicaria Fendleri*, Gray.
90. *Vesicaria lasiocarpa*, Hook.
93. *Draba platycarpa*, T. & G.
94. *Sisymbrium pinnatum* (Ell.), Greene. (*S. canescens*, Nutt.)
91. *Lepidium intermedium*, Gray.

VIOLACEÆ.

125. *Ionidium polygalæfolium*, Vent. (*I. lineare*, Torr.).

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[1] Mentioned in the Bull. Torr. Bot. Club, xiv., p. 68.

POLYGALEÆ.

29. *Polygala ovalifolia*, DC.
142. *Krameria lanceolata*, Torrey.

PORTULACEÆ.

28. *Portulaca parvula*, Gray, Proc. Amer. Acad., xxii., 274.
16. *Talinum lineare*, HBK. (*T. aurantiacum*, Engelm.).

MALVACEÆ.

14. *Callirhoë pedata*, Gray.
174. *Sida diffusa*. HBK.
131. *Sida physocalyx*, Gray.
33. *Abutilon holosericeum*. Scheele. A small form.
171. *Abutilon Texense*. T. & G.
105. *Sphæralcea hastulata*, Gray.
123. *Sphæralcea pedatifida*, Gray.
34. *Hibiscus cardiophyllus*, Gray.

LINEÆ.

97. *Linum Berlandieri*, Hook.
101. *Linum multicaule*, Hook.

MALPIGIACEÆ.

156. *Aspicarpa hyssopifolia*, Gray. A form with leaves broader than in the original, distinctly veined and lanceolate.

GERANIACEÆ.

117. *Geranium Carolinianum*, L.
95. *Erodium Texanum*, Gray.
10. *Oxalis corniculata*, L. A form with close-appressed, cinereous pubescence.
86. *Oxalis dichondræfolia*, Gray.
31. *Oxalis Drummondii*, Gray. Fide Trelease.

RUTACEÆ.

81. *Thamnosma Texanum* (Gray), Torr.

CELASTRINEÆ.

161. *Schæfferia cuneifolia*, Gray.

RHAMNACEÆ.

129. *Colubrina Texensis*, Gray.

AMPELIDEÆ.

69. *Vitis incisa*, Nutt. From a sketch by Miss Croft it would appear that this vine has a thick, moniliform root.

LEGUMINOSÆ.

15. *Lupinus subcarnosus*, Hook.
51. *Eysenhardtia amorphoides*, HBK.
138. *Dalea lasianthera*, Gray.
147. *Dalea nana*, Torr.
175. *Petalostemon gracilis*, Nutt.
84. *Astragalus Nuttallianus*, DC.
23. *Indigofera leptosepala*, Nutt.
83. *Vicia exigua*, Nutt.
22. *Galactia heterophylla*, Gray.
27. *Galactia marginalis*, Benth.
63. *Rhynchosia Texana*, T. & G.
103. *Sophora secundiflora* (Orteg.), Lag.
106. *Cassia pumilio*, Gray.
Proposis juliflora, DC.
162. *Desmanthus Jamesii*, T. & G. ?
154. *Schrankia angustata*, T. & G.
155. *Acacia filicina*, Willd.
157. *Acacia Greggii*, Gray.

ONAGRARIEÆ.

1. *Œnothera Hartwegii*, Benth.
108. *Œnothera rosea*, Ait., with remarkably lyrate root-leaves.
2. *Œnothera speciosa*, Nutt.
111. *Gaura Drummondii*, T. and G.
127. *Gaura sinuata*, Nutt.
109. *Gaura tripetala*, Cav.

PASSIFLOREÆ.

64. *Passiflora tenuiloba*, Engelm.

CUCURBITACEÆ.

68. *Sicydium Lindheimeri*, Gray. (*Maximowiczia Lindheimeri*, Cogn.)

CACTEÆ.

30. *Echinocactus setispinus,* Engelm.

UMBELLIFERÆ.

80. *Bowlesia lobata,* Ruiz & Pav.

82. *Apium echinatum* (Nutt.), Watson, Bibliog. Index, Part i., 412.

81. *Apium Popei* (T. & G.), Gray.

118. *Chærophyllum procumbens* (L.), Crantz, var. *Teinturiei* (Hook.), Coulter & Rose.

120. *Daucus pusillus,* Michx.

RUBIACEÆ.

85. HOUSTONIA CROFTIÆ, n. sp. Annual; depresssed-spreading from a slender, straight root; stems about 25^{mm} long, simple, or dichotomously branching, minutely scabrous; leaves 5 to 10^{mm} long, oblanceolate, tapering into a very short petiole, revolute, obtuse; petioles sparingly ciliate; flowers white, minute (about 3^{mm} long), sessile in the axils; fruit didymous, 2^{mm} high, short-stalked, clothed with short hairs; calyx teeth acute, about half the length of the corolla tube.

A diminutive species in the section of *H. humifusa,* Gray, Syn. Flor. Gamopet., p. 25.

26. *Houstonia angustifolia,* Michx. A branching form.

76. *Galium virgatum,* Nutt. A smoothish, thin-leaved form.

COMPOSITÆ.

53. *Eupatorium Greggii,* Gray.

36. *Eupatorium incarnatum,* Walt.

21. *Liatris punctata,* Hook. the var. γ of Torrey & Gray, having leaves ciliate with rigid hairs.

54. *Gymnosperma corymbosum,* DC.

55. GUTIERREZIA SAROTHRÆ (Pursh.). (*Solidago Sarothræ,* Pursh. Flor. Amer. Sept., ii., 540, 1814; *Brachyris Euthamiæ,* Nutt., Genera, ii., 163, 1818; *G. Euthamiæ.* T. & G.)

47. HETEROTHECA SUBAXILLARIS (Lam.). (*Inula subaxillaris,* Lam., Dict. iii., 259, 1789; *H. Lamarckii,* Cass. 1823.)

42. *Chrysopsis villosa* (Pursh.), Nutt., var. *canescens* (DC.), Gray.

37. *Haplopappus spinulosus* (Pursh), DC.

144. *Aphanostephus humilis* (Benth.), Gray.

41. *Aster multiflorus,* Ait.

136. *Erigeron tenuis,* T. & G.

49. *Achætogeron Palmeri*, Gray?
72. *Evax multicaulis*. DC.
77. *Melampodium cinereum*, DC. A form near var. *ramosissimum* (DC.), Gray.
126. *Engelmannia pinnatifida*, Torr. & Gray.
100. *Parthenium Hysterophorus*, L.
45. *Helianthus annuus*, L.
173. *Helianthus ciliaris*, DC. A form with narrow leaves nearly matching Dr. Palmer's specimens No. 616, from Juraz, Coahuila, 1880.
169. *Encelia subaristata*, Gray. Differing only in the pappus from *E. calva* (Engelm. & Gray), Gray.
38. *Verbesina encelioides* (Cav.), Gray, Syn. Flor. Gamopet., 288. A form with the involucral bracts equalling the rays.
40. *Verbesina Virginica*, L.
170. *Coreopsis cardaminefolia* (DC.), T. & G.
43. *Cardamine*, near the last, and perhaps the var. *linearilobа*, T. & G., but the rays are yellow to the base.
39. *Polypteris Texana* (DC.), Gray.
96. *Hymenatherum tenuilobum*, DC.
133. *Helenium amphibolum*, Gray.
102. HELENIUM SETIGERUM (DC.). (*Amblyolepis setigera* (DC.), fide Benth. & Hook., Gen. Plant., ii., 414.)
128. *Gaillardia pulchella*, Foug.
131. GAILLARDIA SUAVIS (Gray & Engelm.). (*Agassizia suavis*, Gray & Engelm., Proc. Amer. Acad., i., 49, Dec. 1st, 1846; *G. simplex*, Scheele, Linnæa, xxii., 160, 1849.)
46. *Artemisia Mexicana*, Willd., var. *angustifolia*, Schultz, Bip.
35. *Chaptalia nutans* (L.), Hemsley.
141. *Perezia runcinata*, Lag.
48. *Pyrrhopappus multicaulis*, DC. ?
135. *Pinaropappus roseus*, Less.
44. *Lygodesmia aphylla* (Nutt.), DC., var. *Texana*, T. & G.

OLEACEÆ.

13. *Menodora heterophylla*, Moric.

ASCLEPIADEÆ.

70. PHILIBERTIA VIRIDIFLORA (Torrey). (*Gonolobus viridiflorus*, Torrey, Ann. Lyc. N. Y., ii., 219, 1828; *Sarcostemma cynanchoides*, Dec. in DC., Prodr., viii., 540, 1844; *P. cynanchoides*, Gray.)
62. *Metastelma barbigerum*, Scheele.

166. *Gonolobus parviflorus* (Torr.), Gray. On these specimens some of the lower leaves are cordate.

POLEMONIACEÆ.

4. *Gilia rigidula*, Benth.

BORAGINEÆ.

148. *Coldenia canescens*, DC.
134. *Echinospermum Redowskii* (Hornem.), Lehm., var. *strictum* (Nees), S. Wats. (var. *cupulatum*, Gray).
104. *Lithospermum canescens* (Michx.), Lehm.

CONVOLVULACEÆ.

66. *Ipomœa Nil* (L.), Pursh. (*I. hederacea*, Jacq.)
67. *Ipomœa trifida* (HBK.), Don, var. *Berlandieri*, Gray.
139. *Convolvulus hermannioides*, Gray.
143. *Evolvulus sericeus*, Swartz.
6. *Cuscuta indecora*, Choisy, var. *pulcherrima* (Scheele), Engelm.

SOLANACEÆ.

5. *Solanum eleagnifolium*, Cav.
11. *Physalis Fendleri*, Gray, var. *cordifolia*, Gray, Syn. Flor. Gamopet., 1st Ed., p. 395, ex. descr.; name not in 2d Ed.
75. *Chamæsaracha sordida* (Dunal), Gray.
179. *Capsicum baccatum*, L.
132. *Nicotiana repanda*, Willd.
32. Boucheti aanomala (Miers). (*Nierembergia anomala*, Miers, Lond. Journ. Bot., v., 175, 1846; *Bouchetia erecta*, DC., Prodr., xiii., i., 588, 1852.)

SCROPHULARINEÆ.

50. *Leucophyllum Texanum*, Benth.
92. *Linaria Canadensis* (L.), Dumort. A form with larger flowers than ordinary.

OROBANCHACEÆ.

153. *Aphyllum multiflorum* (Nutt.), Gray.

ACANTHACEÆ.

151. *Calophanes linearis* (T. & G.), Gray.
150. *Ruellia tuberosa*, L.
165. *Siphonoglossa Pilosella* (Nees), Torr.

VERBENACEÆ.

52. *Lantana Camara*, L.
79. *Verbena canescens*, HBK.
78. *Verbena ciliata*, Benth.
119. *Verbena officinalis*, L.

LABIATÆ.

140. *Hedeoma Drummondii*, Benth.
172. *Salvia ballotæflora*, Benth.
137. *Salvia Texana*, Torr.
159. *Monarda clinopodioides*, Gray.
99. *Scutellaria Drummondii*, Benth.

PLANTAGINEÆ.

112. *Plantago Patagonica*, L., var. *gnaphalioides* (Nutt.) Gray.
110. *Plantago Virginica*, L.

NYCTAGINEÆ.

158. *Nyctaginea capitata*, Choisy.
176. *Allionia incarnata*, L.
145. *Acleisanthes longiflora*, Gray.

PHYTOLACCACEÆ.

9. *Rivina lævis*, L.

POLYGONACEÆ.

115. *Rumex Berlandieri*, Meisn.

ARISTOLOCHIACEÆ.

124. *Aristolochia longiflora*, Engelm. & Gray.

EUPHORBIACEÆ.

168. *Euphorbia melanodenia*, Torr.
74. *Euphorbia Peplidion*, Engelm. (Determined by Dr. Sereno Watson).
3. *Phyllanthus polygonoides*, Nutt.
25. *Croton capitatus*, Michx. (?)
164. *Acalypha hederacea*, Torrey.

167. *Tragia ramosa*, Torrey, 1828. (*T. stylaris*, Muell. Arg., 1865.)

24. STILLINGIA DENTATA (Torr.), (*Sapium* (?) *annuum*, Torr., var. *dentatum*, Torr., Bot. Mex. Bound. Surv., p. 201, 1859; *Stillingia Torreyana*, S. Wats., Proc. Amer. Acad., xiv., p. 298, 1879.)

URTICACEÆ.

122. *Urtica chamædryoides*, Pursh.
73. *Parietaria debilis*, Forst.

AMARYLLIDEÆ.

18. *Cooperia Drummondi*, Herb.
17. *Zephyranthes Andersonii* (Herb.), Benth. & Hook., Gen. Plant., iii., 724 (*Habranthus Andersonii*, Herb.).

LILIACEÆ.

107. *Allium mutabile*, Michx.
71. *Nothoscordum striatum* (Jacq.), Kunth.

COMMELINACEÆ.

8. *Commelina nudiflora*, L.
7. *Commelina Virginica*, L.

CYPERACEÆ.

180. *Cyperus aristatus*, Rottb.

GRAMINEÆ.

(Determined by Dr. George Vasey.)

57. *Panicum leucophæum*, HBK., var. *leucanthum*, Vasey.
178. *Setaria setosa*, Beauv., var. *caudata*, Griseb.
116. *Thurberia Arkansana* (Nutt.), Vasey.
56. *Andropogon saccharoides*, Swartz.
72. *Stipa setigera*, Presl.
60. *Chloris cucullata*, Bisch.
61. *Trichloris pluriflora*, Fourn.
58. *Bouteloua hirsuta*, Lag., var. *minor*, Vasey.
59. *Bouteloua racemosa*, Lag.

MARSILEACEÆ.

121. *Marsilea macropoda*, Engelm.

Prof. H. Carrington Bolton exhibited a photograph of the skeleton of Iguanodon recently mounted in Brussels; and Prof. D. S. Martin spoke of the character and affinities of the reptile.

Adjourned, as a business meeting, to October 17, 1887.

October 10, 1887.

Stated Meeting.

The President, Prof. J. S. Newberry, in the chair.

Twenty-three persons present.

The Librarian read a notice of the proposed semi-centennial celebration of Der Naturwissenschaftliche Verein in Hamburg, on November 18, 1887, and it was voted to authorize the Corresponding Secretary to transmit the congratulations of the Academy.

A memorial to the Congress of the United States, asking the enactment of a law to protect forest lands, prepared by the American Forestry Congress, was presented for signatures. It was moved and voted to authorize the *Officers of the Academy* to sign this petition as such officers.

Prof. O. P. Hubbard exhibited an *antique*, brought from Cuzco, Peru, several years ago, in the form of a turtle, of a bright yellow color, and obviously a hard alloy of gold.

He had found no mention of such a relic in the works of Squier and Tschudi on South America, or in the larger work on the excavations in the ancient cemeteries of Antioquia, and it is thought to be unique.

He gave the following

Description: Its weight, $1\frac{3}{4}$ oz. av.; length head and tail, $2\frac{1}{4}$ in.; breadth across forelegs, $1\frac{3}{4}$ in.; height of head, $\frac{13}{16}$ in.; do. carapace, $\frac{3}{4}$ in.; width of head including projecting eyes, $\frac{5}{8}$ in.; eyes, $\frac{3}{16}$ in.

Head, front vertical, $\frac{5}{8}$ in.; beak, pointed, strong, recurved under lower jaw. A beautiful three-ply braided cord $\frac{1}{16}$ in.

wide encircles the figure and covers the junction line of carapace and plastron, reaching behind the neck.

Carapace quite symmetrical, convex, elliptical, without figures. Plastron a transverse central plain band $\frac{5}{8}$ in. wide, with transverse open space before and behind, $\frac{1}{4}$ in. wide, exposing the whole cavity and under surface of the carapace, which is studded with small prominences, as if left in casting.

The four legs are variously figured, and the two hind ones have, in a line near the body, three small round points.

The head is as if supported by two *ligamenta* (?) $\frac{1}{4}$ in. wide, in three bands each, the inner one with 15 small triangular perforations on outer curved line. These are attached on right and left of carapace, and curve down and out over forelegs in a circle and a half, to the carapace in front.

On anterior plastron, right and left, at the insertion of the legs, are two eye-bolts, through which, with a cord, the turtle can be suspended if worn as an ornament or amulet.

Prof. Hubbard also exhibited a specimen of *claystone* from a railroad cut at Sharon, Vt., which presented a striking imitation of the form of a small turtle of $1\frac{1}{4}$ in. diameter.

The President exhibited specimens of eruptive rocks from the base of Mt. Beckwith, Colorado, a quartz-mica-diorite, with crystals of sanidine and moonstone.

Mr. F. J. H. Merrill read a paper entitled

NOTES ON THE AGE OF THE LIMESTONES OF WESTCHESTER CO., NEW YORK.

The paper was discussed by Dr. Britton and President Newberry.

Prof. D. S. Martin presented the following notice of

THE "FIELD OF ROCKS."

About eleven miles west of Philadelphia, on the main line of the Pennsylvania Railroad to Pittsburg, there occurs a most remarkable isolated deposit of large boulders, presenting a very peculiar problem to the geologist, inasmuch as the locality is far to the south of the well-determined line of the Great Terminal Moraine.

A year or two ago, while visiting friends in this region, I had heard the spot referred to as one of the local curiosities, but had no opportunity to examine it. This year, on returning to the same place, I determined to make personal inspection of the phenomenon.

Parallel to the Pennsylvania Railroad, a little way south of it, runs the beautifully kept and planted road known as the "Lancaster Pike;" this is crossed, some three miles west of Bryn Mawr, and between Villa Nova and Radnor, by the "Spring Mill" road, going southwest from Villa Nova station. A few rods beyond this crossing, on the south side of the pike, the succession of cultivated farms, grounds, and country seats is interrupted by a piece of young woodland, as thick and wild with flowers and undergrowth as though it were miles away from the dwellings of men. On entering it, and forcing one's way through the thickets, the reason soon becomes apparent for the state of nature in which this ground has remained. The wood is filled with boulders, many of them of great size, masses of rock in some cases fifteen feet across and seven or eight feet high. All are so weathered that their character is unrecognizable; but on chipping away fragments, they seem to be generally alike, a dark fine-grained gneiss, with occasional thin seams of quartz.[1] So remarkable was the deposit that I was at first disposed to believe that they must be boulders of decomposition; but there is nothing similar in the neighborhood so far as I have examined. On the contrary, as a rule, the rock of the region exhibits very uniform and complete disintegration into soil. Nowhere could the "southern drift" type. of regular undisturbed passage from surface-earth by insensible gradation into stratified gneiss, be more clearly seen than at various points in this neighborhood, wherever exposed; while weathered ledges or solid outcrops are scarcely to be found. Further west, indeed, among the Radnor Hills, and on the Valley Forge Hills to the north, rock exposures occur more freely. But on the other hand, occasional smaller boulders, unmistakably such, are seen here and there in the roadsides and fields around.

The spot is locally known as the "Field of Rocks," and is certainly a remarkable feature. It was formerly, I am told, a favorite place for picnics, etc., but of late years it is so grown up with young woods as to be almost inaccessible, and quite invisible from the adjacent road.

I am at a loss to frame a satisfactory theory as to these great

[1] Dr. Britton, on examining the pieces presented, stated that the rock was perfectly familiar to him as the gneiss of the New York "Highlands."

boulders. The drift area lies far to the north; and the decomposed rock of the region, above referred to, gives the clearest evidence that no land ice has ever moved over this neighborhood. The only explanation suggested is that of transportation by drifting ice, the stranding of some great rock-laden floe or berg, broken from the edge of the ice-sheet to the north or from local glaciers on the hills to the west.

The PRESIDENT briefly described the mountain region of Western Colorado, which he had recently visited.

October 17, 1887.

ADJOURNED BUSINESS MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Twenty persons present.

A Report of the Council made the following recommendations :—

I. The acceptance of the resignations of the following members: Mr. Albert S. Bolles, Lt. William S. Dana, Rev. B. F. DeCosta, Mr. Charles H. Denison, Dr. Julius Sachs, Rev. George L. Shearer, Mr. Joseph Yates.

II. The election of the following persons as resident members:

MRS. MARTHA J. LAMB.
MRS. SARA LOUISE SAUNDERS.
MISS LILLIE E. WARREN.
DR. STEPHEN SMITH.

III. The payment of certain bills.

IV. That an invitation be extended to the *Local Committee of the American Association for the Advancement of Science,* to attend a meeting of the Academy, and that an appropriation be made to pay the cost of a collation.

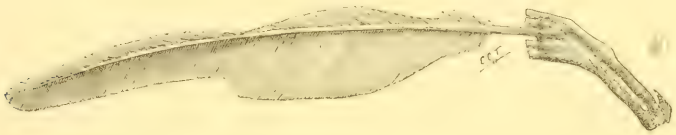
The recommendations were severally adopted, except the election of members, which was deferred, under the rule, to the Regular Business Meeting.

Prof. W. C. Trowbridge announced

A DISCOVERY BY C. C. TROWBRIDGE REGARDING THE PURPOSE OF THE EMARGINATION IN THE PRIMARY WING-FEATHERS OF CERTAIN BIRDS.

My son, C. C. Trowbridge, a student in the Hopkins Grammar School at New Haven, called my attention recently to a fact which he had observed, viz., that the emarginate cuttings of the primary feathers of certain birds are designed to enable the birds to interlock, at will, these feathers in an extended position, in order, presumably, to relieve the muscles of the tip of the wing from prolonged or continuous exertion during flight.

From my own examination of the specimens which he brought



to my notice I am quite sure of the truth of his observations; but although the facts were quite new to me, and especially interesting in connection with the mechanism of flight, I hesitated to make any announcement of the discovery until I could consult those who were likely to know whether the facts observed had been before noticed or described.

The results of my inquiries were that, while ornithologists have, of course, known and described the peculiar cuttings of the feathers, the purposes subserved by the shape thus given to them have hitherto escaped observation.

I accordingly requested my son to make such drawings from wings in his possession as would serve to explain or illustrate the mode by which the primaries are interlocked. The figures

hereto annexed are copied from his drawings. The first represents one of the primary feathers, and shows its peculiar emargination along parts of both the upper and lower edges. The next cut exhibits the interlocked primaries as they appeared in the wing of a red-shouldered hawk (*Buteo lineatus*). In this figure it will be seen that the cutting of the lower margin of each primary extends from the tip of the feather, a distance corresponding to the cutting of the upper margin of the feather below it. In this particular case the cuttings extend about half the length of the feathers.

The same figure shows how each of the primaries, beginning with the outer one, can, for a distance, corresponding to these emarginations, be thrown behind the succeeding primary, crossing it in such a way that the effect is to interlock the primaries in an open or extended position.

The muscular action by which this locking and unlocking can be accomplished at will, appear to be as follows: Referring again to the second figure, which represents the wing as it would be presented to an observer standing on the ground and looking upwards at a bird soaring above, the primaries corresponding to the fingers of the human hand now interlocked, are capable of being extended and opened by means of a muscle, the tendon of which lies along the bones which form the hand. This tendon is shown in the figure, detached from the muscle at one end and separated from the bone. A force exerted along this tendon opens the primaries by acting upon a lever of the third order, but with great disadvantage as far as the leverage is concerned.

If the muscle be relaxed while the feathers are extended, the latter will fall together like the leaves of a fan, as they are always seen when the wing is folded. This is the process of unlocking. If, however, the bird wishes to lock the feathers, they are first extended by the muscle referred to, and a rotary muscle rotates the hand slightly in such a way that if the extensor muscle is suddenly relaxed the primaries may fall into their interlocked position, especially if the tips of the feathers are bent backward by a slight stroke of the wing at the same instant.

The operation of locking and unlocking may thus be performed almost instantaneously and at will.

This discovery throws much light on the mechanics of flight; especially of soaring flight.

Some birds remain soaring for hours at a time, far above the earth, without flapping their wings. During this time, it is hardly possible that the primary feathers could be kept extended solely by the continued exertion of the comparatively small and weak extensor muscle, which has been referred to. The re-

freshment of a muscle can only take place ordinarily by its relaxation. Even a momentary relaxation is often sufficient; but without such relaxation, exhaustion of the muscle soon takes place.

Dr. Houghton found, from numerous experiments, that the muscles of the human arm, extended and supporting a weight of two pounds held in the hand, became completely exhausted in four minutes. By the interlocking of the primary feathers of the wings of birds, the extensor muscles of their feathers are completely relieved, and rapid exhaustion prevented. And if we consider, further, that when the body of the bird is suspended or hung between the extended wings, it is probable, and, indeed, may be demonstrated as almost certain, that the action of the air pressure from beneath serves to keep the whole wing extended at the elbow without appreciable muscular effort; the only effort in soaring is thus merely that which gives the slight movements to the tail and wings by which the body is guided or steered with or against the air currents.

The PRESIDENT spoke upon the problem of the soaring of birds, and favorably commented upon the discovery claimed by Prof. Trowbridge.

CAPT. A. W. VOGDES exhibited an album of *Algæ*, once the property of Prof. Harvey, which were the types of the descriptions by that author in his "North American Algæ," published by the Smithsonian Institution.

DR. ALEXIS A. JULIEN read a paper entitled:

ON THE GEOLOGY AT GREAT BARRINGTON, MASSACHUSETTS.

An examination of the limestone belt of Western New England, at various points, leads me to present the following views:

First: In proof of the local existence of smaller dolomytic beds, distinct from the main sheet and lying at a higher horizon.

Secondly: In explanation of the peculiar physical and mineralogical characteristics of the material of these outliers, as illustrated by one in the town of Great Barrington, Massachusetts.

I. General Stratigraphy of the Stockbridge Limestone.

Recent geological investigations have shown that this sheet of crystalline limestone, which, for the sake of convenient distinction, has been called the "Stockbridge Limestone," extends for

a distance of one hundred and seventy miles, from New York to Vermont, over an area of at least eight hundred square miles. With this limestone, usually the bottom layer of the series, are commonly associated beds of mica-schist, mica-slate, and gneiss, underlying, interstratified, or overlying. Next above, comes a layer of quartzyte (often passing into gneiss), then one of schist or gneiss, then another layer of quartzyte (that which forms the crest of Monument Mountain, north of Great Barrington), and then a series of thin beds of gneiss, schist, quartzyte, and limestone (best shown at Three Mile Ridge, four miles east of Great Barrington).

The whole series is fortunately crumpled up everywhere into sharp folds, which, by the erosion of ages, have been worn down or cut into at many points, thus bringing up the limestone layer into view here and there. In this way it crops out first as a coarse marble, at a point south of Pawling, in Dutchess County, New York; then at many points, becoming finer grained in its progress northward, over a stretch of seventy miles, to Pittsfield, in Western Massachusetts, along the Housatonic and two neighboring valleys; and then, for a hundred miles farther, in fine soft marbles, to a point twenty miles north of Rutland, in Vermont.

The uniform lithological character of this limestone-sheet is in general strongly marked; although this is attended by a considerable variation in texture, from grains 1 mm. or less in diameter, in the northern part of the belt, to grains over 1 cm. in diameter near its southern extremity. Its color is predominantly white, with light bluish or grayish bands, variously disposed and occasionally overspreading and darkening the entire material. These darker variegations consist of drawn-out plates and films of clay-slate or hydromica-slate, in which, where thickest, a small proportion of iron pyrites is sometimes concentrated.

The employment of the material as an ornamental marble, or as a building-stone at many localities, has led to abundant determinations of its weight, compressive strength, and structure, which have been found to vary but little along its course of outcrop.

The accessory minerals it contains are usually the same—tremolite, magnesian mica, rutile, tourmaline, etc., together with a species of iron pyrites which, in many localities, from New York to Vermont, is unfortunately subject to ready decomposition.

The common distribution along the main belt of a rather pure limestone, only occasionally somewhat magnesian, may be inferred, even by the traveller, from the numerous kilns in

which much of its material has been found suited to burning lime—and by the chemist, from a comparison of the following published analyses of samples of this rock from the most widely separated localities, arranged from Vermont southward.

ANALYSES OF MARBLES AND CRYSTALLINE LIMESTONES.

Locality.	Variety.	Calcium carbonate.	Magnesium carbonate.	Quartz and clay.	Ferric oxide (and alumina).	Water.	
Brandon, Vt.	....	99.51	tra	0.29	none	....	....
Pittsford, Vt.	Florence.	99.05	0.29	0.31	0.15	....	With a little graphite.
" "	Gray.	98 37	0 60	0.63	....	....	
Hydes' Quarry, Rutland, Vt.	....	97.73	none	1.68	0.59	....	
West Rutland, Vt.	White.	99.25	0.35	0.18	0.10	....	
West Rutland, Vt.	Dark bluish gray.	96.30	2.41	0.92	0.10	0.27	With a little graphite.
Plymouth, Vt.	....	53.90	44.70	....	1.30	....	
Bristol, Vt.	....	51.35	44.76	1.40	2.00	....	
East Dorset, Vt.	Dark.	96.28	2.94	0.67	0.10	....	
East Dorset, Vt.	Light.	96.07	2.33	1.42	0.07	....	
Lee, Mass.	White, with grayish streaks.	53.78	45.50	0.20	0.30	....	Pyrite, 0.18. The lime-kiln near this quarry indicates the occurrence of more calcareous layers.
West Stockbridge, Mass.	Dark gray.	81.34	13.33	3.55	0.15	0.70	Pyrite, 0.37.
East Canaan, Mass.	Gray.	54.64	44.35	0.35	0.30	0.30	
Mansfield Woodhouse, Eng.	Yellow and hard.	51.65	42.60	3.70	trace	2.50	Both stones remain perfect in buildings of the twelfth century.
Bolsover Moor, Eng.	Yellowish-brown and compact.	51.10	40.20	3.60	1.80	3.30	
Mansfield, Eng.	White siliceous.	26.50	17.98	51.40	1.32	2.80	

Unfortunately these analyses are merely chemical, unaccom-

panied by microscopical and physical examinations, and more or less incomplete; so that we cannot obtain the exact knowledge we need of the mineralogical constitution of the material. This objection equally applies to the two analyses, at the bottom of the table, of English dolomytes, celebrated for their durability. Chemical analysis alone may be entirely misleading in its bearing on the practical application of such stones to building purposes.

Their strength and durability may depend partly upon the minerals of which they are constituted, *i. e.*, whether easily cleavable, soluble, or inclined to alteration, and partly upon the mode in which these constituent minerals are mutually arranged and cemented. The table shows that the majority of these marbles are nearly pure crystalline limestones, *i. e.*, consist chiefly of calcite; the comparative softness and solubility of the grains, and the loose texture of their arrangement, account for the inability of nearly all of these marbles to endure either heavy pressure or long weathering.

Others are dolomitic limestones, their grains are comparatively hard, strong, and insoluble; but their texture is so loose from the feeble mutual adherence of the grains, or their content of some soluble or oxidizable mineral, *e. g.*, iron carbonate, is so great, that some of these stones also may be unfitted to resist either pressure, weather, or handling. Finally we have, in some of the famous crystalline dolomytes of England, materials fitted to resist all strain or attack, by their insolubility, closely compacted texture, and in some cases the filling up of all interstices by solid quartz.

Near the northern end of the limestone belt now under consideration, in the fine quarry at Sutherland Falls, Vermont, an excellent opportunity is afforded to study the genetic history of this marble, perhaps the most compact and dense of any in that State, and the one exceptionally well fitted in that respect for out-door exposure as a building-stone. Though remarkable for its general whiteness and fine grain, this marble is in part variegated with delicate bands of gray and bluish-gray color, which may be straight and parallel, more or less wavy, and even broken up into isolated patches of the grayish tints. On the face of the strata, at the back of the quarry, a few of these bands are more decidedly accentuated and continuous from top to bottom; on one side inclining downward to the left (north), and on the other to the right (south). They thus obscurely mark the original stratification and the position of the axis of a synclinal fold; while their zigzag plications indicate the intense condensation and consolidation which the material has experienced during the process of folding. Of this action, the fine grain,

hardness, great weight, and high compressive strength of this stone are the natural results. At Lee, Massachusetts, toward the southern end of the belt, the beds of fine white to blue-gray marble, though but gently inclined, present similar physical characteristics, a sparse but general distribution of magnesian mica, tremolite, and minute particles of an unstable form of pyrite, and a more marked inclination to laminated structure.

This lamination becomes a more decided feature in the gray limestone of Stockbridge and the marbles of Sheffield and Canaan to the south.

To these well-known characteristics I may add the fact of the peculiar mode of disintegration which affects this rock, under the influence of the weather and percolating moisture, as shown in the sides of quarries and outcrops throughout the distribution of the sheet, from Vermont to Connecticut. The material becomes finely cracked up by a network of minute irregular crevices, but is also often seamed by long cracks parallel to the planes of bedding, especially within a few inches of the natural division-surfaces.

The object of this review has been to impress the conclusion of the general lithological uniformity of this limestone-sheet, with the unimportant exception of those subordinate characteristics which depend mainly upon local variations in mode and degree of crystallization. On the other hand, however, it has been found that a highly magnesian composition, approaching more or less closely to that of a true dolomyte, belongs to certain beds, usually accepted as portions of the same continuous sheet, which occur mostly on each side of the central band and around its southerly termination. There is sufficient evidence, in my opinion, to lead us to recall the view, at one time suggested by Prof. Dana, and to consider at least many of these dark-colored beds, so highly magnesian as to be entirely unfit for burning to lime, not as parts of the main limestone-sheet, but members of a series of intermittent occurrence lying above it. Their material differs in some mineralogical characteristics. Tremolite is, in general, entirely absent; quartz becomes a noteworthy constituent; even the pyrite is sometimes of an entirely distinct variety, which resists decomposition; and the pure gray color, common to dolomytes, often supplants the white. In spite of the difficulty of identifying the relationship of strata folded together in complicated confusion, with important members of the series entirely carried away at one point by erosion, at another completely hid from view by overlying bodies of sand and clay, there is ample evidence, at least in the neighborhood of Great Barrington, and at points both to the east and west of that place, of the occurrence of this upper dolomitic series. The

geology in the immediate vicinity of Great Barrington has been carefully studied by J. D. Dana.[1] Its stratigraphical features have been represented by him in a cross-section from the hill west of the village, eastward through the village, which occupies the low portion of the valley, to East Mountain, which bounds the Housatonic valley on the east.

On the summit of the hill, at the west end of the section, given in his paper, we find an outcrop (*l*) of the "Stockbridge limestone," as a coarse white crystalline variety, then a stratum, over three hundred feet in thickness, of mica-schist (and gneiss) (*s*), quartzyte (*q*), and micaceous gneiss (*s*), and then a layer of "limestone," all these members dipping eastward at an angle of 45° to 55°. Then at *P*, near the centre of the valley, rises the isolated ridge of "limestone" (*l*), called Mt. Peter, dipping 70° to 80° to the eastward, and again another (at *l*), east of the river (*H*), on the lower slope of East Mountain, dipping 80° to 85° to the westward. In regard to these outcrops of so-called "limestones," Dana observes: "This section introduces a new element, *an upper stratum of limestone*, overlying the upper schist where the upper quartzyte would be looked for. The limestone is a bluish-gray and firm granular variety. Some portions are quite pyritiferous. I have been unable to find evidence that this limestone is a continuation, in full, of that of Egremont. The section terminates eastward in a thick stratum of contorted gneiss (S^2), with one hundred and twenty feet of quartzyte above. The gneiss dips eastward 60° to 50° in the outcrop nearest the limestone, diminishing eastward to 50° and 40°, with the strike about N 10° E. Some of the outcrops of limestone and gneiss are not over ten yards apart. The unconformability between the gneiss and limestone is evidence of a fault along a fracture."

A year afterward (October, 1873), Prof. Dana withdrew this conclusion as to the existence of a second independent stratum of limestone at Great Barrington:

"The importance of settling this point has led to the delay in the publication of this continuation of my memoir. Having been recently over the ground again, I have finally arrived at the conclusion that the ridge of schist west of Great Barrington is actually the course of a synclinal, and, that, therefore, the Great Barrington limestone stratum dips under it, and is nothing but the Stockbridge stratum. There is no outcropping schist found to the south of it. Again, the connection of the quartzyte of this ridge with that of the south end of Tom Ball (a high ridge three miles northwest of Great Barrington), and

[1] Amer. Jour. Science, 3, iv. (1872), v. and vi. (1873).

the fact that Tom Ball is itself the course of a synclinal, sustains the above conclusion. Hence I now believe that there is in the region no second or upper limestone stratum."

Immediately after this, Prof. Dana describes the section at the south end of Beartown Mountain, four miles east of Great Barrington, in which the following succession occurs, commencing below :

" 1. White granular limestone, that of the valley.
" 2. Mica-schist, a thin bed.
" 3. Hard jointed quartzyte, 30 feet.
" 4. Some limestone, 60 feet.
" 5. Quartzyte, like the lower, 20 feet.
" 6. Gneiss, 30 feet.
" 7. (North of the road) Bluish granular limestone, crumbling.
" 8. Mica-schist, 6 to 8 feet.
" 9. Quartzyte, 100 feet (Devany's quarry).
" 10. Gneiss (overlying the quartzyte at the quarry)."

Having had the opportunity to give special study in this region to the dolomyte tracts in the immediate vicinity of Great Barrington, on both sides of the river, I have worked out several facts in supplement or correction of the general section of Dana across the valley at that point ; this I offer in modified form as Fig. 1.

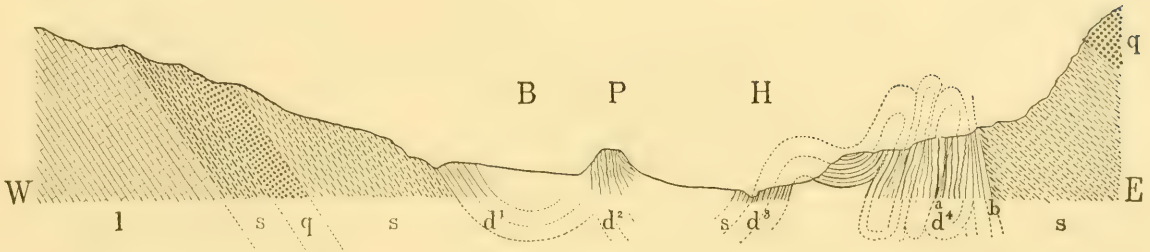
In the former section, the dolomyte of the little elevation of Mt. Peter, rising on the west part of the valley, was represented as lying in a stratum dipping steeply to the east. However, there are here many slight but significant variations in the dip, both in degree and direction, which seem to me to indicate the presence of one or more sharp folds, though with a general easterly inclination.

No rock was shown in the low ground between Mount Peter (*P*) and the Housatonic River (*H*); but I have found that the gneiss occupies at least part of this space near the river, in a highly tilted bed, dipping 60° to the west.

Again, in the place of the hiatus between the river (*H*) and the east outcrop of the dolomyte on the right (*L*), a continuous outcrop of the dolomyte occurs, down to the river and even in its very bed. Within the dolomyte tract itself, especially where freshly uncovered in quarries, many variations of the dip occur, which plainly indicate a series of five sharp and partly reversed folds, traversed by two faults. This conclusion has been reached from the following observations of the dip of the beds of dolomyte, on a line passing eastward from the river to the base of East Mountain.

FIG. 1.

Geological cross-section through the Housatonic Valley at Great Barrington.



l, underlying stratum of Stockbridge limestone.
s, schist or gneiss.
q, quartzyte.
d, dolomyte of the Housatonic Valley, at the site of the old Briggs' Quarry (d^1), at the quarries of Mount Peter (d^2), in the bed of the Housatonic (d^3), and at the Hopkins' Quarry (d^4).
a, an ancient fault.
b, more recent fault.
B, Great Barrington.
P, Mount Peter.
H, Housatonic River.

	DIP.
At level of the river, on Mr. Jason Cooley's property	60° N. 35° W.
In lower road, just south of Cooley's	30° E. 40° S.
Opening on Humphrey's lot	70° W. 19° S.
Ledge on the slope between the two roads, on the west side of the road, and also at northwest corner of quarry: lamination rather wavy	80° W.
Ledge at roadside, at the quarry	85° W.
By the roadside at S. W. corner of the quarry	75° W.
In quarry, at extreme S. W. corner	80° W.
A yard further to east of preceding	Vertical.
At W. side of quarry, at the quartz vein	65° E. 6° S.
In quarry, 60 feet east of road, a bent fold	above, 70° W. below, 87° E.
On south side of quarry, bent fold	above, 67° W. below, 87° W.
On N. E. part of quarry	60° W.
In quarry, 100 feet east of road	55° W.
Course of veins, 5° E. and W. of N. Contorted layers now intervene, all with high dip to the west. In S. E. corner of quarry	50° W.
Top of quarry, near the middle	80° W.
In quarry, 200 feet east of road, with wavy lamination	85° W.
These layers assume a gentle curve, so as to become nearly vertical at the bottom of the quarry, over 30 feet below.	
In quarry, 240 feet east of road, near site of old smithy	87° E.
S. E. corner of quarry, wavy lamination	Vertical.
At upper end of quarry, 270 feet east of road	80° E.
Ledge, 15 feet from gneiss outcrop. Vertical, or	85° E. 30° N.
Ledge, 2 to 3 feet from gneiss	70° E. 10° N.
Gneiss, at the line of contact or fault	56° E. 15° N.
Gneiss, a yard further to east	50° E. 16° N.
Gneiss, at a few yards east of line of contact	40° E. 10° S.

In order to determine the true character of the contact of the dolomyte and gneiss at the spring above the quarry at the foot of East Mountain, I had a trench dug between the nearest outcrops of the two rocks, and a good section was uncovered. It was thus shown that the eastern limit of the dolomyte had been reached, and that the dolomyte lamination passed from a vertical position to an increasing easterly dip, which, at the line of contact, exceeds that of the gneiss by only 14°; the amount of the inclination of the beds of gneiss also rapidly decreases, going

eastward. A small slip or fault (*b*) occurs here, as stated by Dana, and is the cause of the welling up of the cold spring; though the unconformability is quite small—only that which is often observed in sharp folds, at the contact of two rocks of different materials and pliability.

Here, as usual in western Massachusetts, even the slightest differences in the inclination of the highly tilted layers possess peculiar significance. That they are indications of the presence and axes of long sharp folds of the whole stratum, and not merely of unimportant plications, is shown by their general continuance along the strike over the whole outcrop of the dolomyte.

These observations, to my mind, therefore, appear to indicate a quite different stratigraphical relationship and folding of beds than those presented in Prof. Dana's last paper and section on this subject. In place of the simple monoclinal dips shown on each side of the river, there would rather appear to be a long series of very sharp folds; at least five occur in the dolomyte outcrop on the eastern bank, which I have studied most carefully, and are shown in my section. These testify also to the comparative thinness of the gray magnesian bed thus crumpled, which could hardly be a continuation of the thick stratum of white Egremont marble on the west.

I am, therefore, convinced that we must return to the view first proposed and later abandoned by my predecessor in this field. The stratigraphical evidence is very strong that the sheet of "Stockbridge limestone," which outcrops in the white marble of Egremont on the west, dips entirely under the Housatonic valley at Great Barrington, and then reappears only as the lowest members (No. 1, or Nos. 1 and 4) of the series of Beartown Mountain, four miles east of Great Barrington. The blue-gray dolomyte tracts in the Housatonic valley near that town probably correspond, in my view, to the "bluish granular limestone" (No. 7) in the upper part of the Beartown series.

As to the further argument of Prof. Dana, founded on the relation of the associated quartzite at Great Barrington to that of the Ridge of Tom Ball, I have not yet examined the latter locality and must present my observations as they stand.

II. The Dolomyte Stratum at Great Barrington.

Other reasons for the stratigraphical distinction which has just been made will be found, I think, in some of the characteristics of this local stratum.

Division-planes of the Dolomyte.

Whatever the exact system of crumpling may have been, in that far distant time when the edges of our continent were shrinking along the ocean-border, and the mountains of western Berkshire were swelling up into vast folds, there can be no question but that the heavy pressure must have resulted in a notable condensation of all the materials thus squeezed up together. We might expect to find at such points, where the folds were sharpest and the pressure most intense, a cementation or soldering of materials into solid masses; and this in fact we do find at this point in the valley. The schist or gneiss at some places is compacted, in spite of its original slaty structure, into a dense material which becomes a good building-stone. To the same intense pressure, soldering together the sharp folds, the dolomyte masses which occupy the Housatonic valley are indebted for their consolidation and remarkable compactness. During the folding, the main pressure was probably borne by the upper and lower thick masses of stiff gneiss and quartzyte. Of these the upper, of which a remnant now makes up the East Mountain, then formed a great fold over the position of the present valley. After the main folding had been accomplished, reaction ensued, bringing down vertically upon the dolomyte layers the superincumbent weight, with a force equal to that required for the elevation.

By the pressure of the dolomyte, while still in a plastic state, up against the crown of this arch, its own particles rearranged themselves at right angles to the vertical line of pressure, so as to produce a new horizontal bedding. An accompanynig horizontal thrust of the whole mass of strata-dolomyte, gneiss, and quartzyte, probably northward against the mass now represented by Monument Mountain, has produced, within the dolomyte, another series of lines of division, vertical and running east and west.

The original material appears to have been a thinly laminated or slaty magnesian limestone, probably possessed of little more compactness or strength than much of the "Stockbridge limestone" of the layer below. By the intense pressure and the heat thereby produced, this earthy magnesian slate was converted into a crystalline marble. Where compressed in a few folds, as at Mt. Peter, the pressure was sufficient to produce a compact rock, which, though still slaty, has yielded a very fair building material for over a half century to the citizens of Great Barrington.

But on the east side of the Housatonic, the series of five sharp and narrow overturned folds, into which the dolomyte

layer has been crumpled up against the huge abutting mass of distorted gneiss which makes up the base of East Mountain, has been soldered together into a rock of extraordinary compactness in which the original slaty structure has been almost entirely obliterated.

In addition to the secondary bedding structure, by which the stone, especially at its eastern outcrop, is divided into thick and nearly horizontal layers, we also find many nearly vertical fissures, running about N. and S., *i. e.*, with the strike and lamination—evidently remnants of the old bedding-planes of original deposit. There is besides a cross-set of strongly marked master-joints, trending nearly E. and W. (E. 10° N. or E. 10° S. to W. 10° S. or W. 10° N.). By these numerous division-planes the mass of the rock is naturally cut up into huge blocks, oblong and angular. In many of them, near the surface, the rounding off of corners, by subterranean decay, has converted the form into that of elongated, often egg-shaped boulders. The results of these planes of subdivision can be readily seen in an ordinary quarried block of the stone.

First, its elongated or sometimes flattened, slab-like shape indicates the regular horizontal bedding, the position in which it lay before it was hewn out—the "bed," "free grain," or "rift" of the quarrymen. The stone cleaves easily parallel to the broader flat faces of such a block.

Secondly, the stone cleaves less readily in another direction, vertical and at right angles to the former, which is generally shown by two even faces at opposite ends of the block. This was originally caused by the horizontal thrust of the folded strata, and marks the "cross-grain" of the quarrymen.

Thirdly, a series of dark gray and grayish-white lines and bands, straight or zigzag, over four faces of the square block, indicates only the edges of the lamination-plates, marking the lines of the original horizontal deposit of successive thin layers of sediment. With the exception of certain slates and granytes, these lines would show in ether rocks, *e. g.*, sandstones and limestones, the present surface of bedding and of easiest cleavage. The exception in this case is almost unique among the magnesian limestones or dolomytes. The original slaty structure has been obliterated by the subsequent folding and pressure, and there is no longer any tendency to cleave in this direction—the "mock grain" of the quarrymen. The distinction between these three directions is of the utmost practical importance; since past experience with other stones always inclines a stone-cutter to attempt to cleave such a stone in the last direction or "mock grain," with the result of loss of labor and often the waste of a valuable block.

The quarrymen of the compact crystalline rocks of Maine have long been accustomed to make distinctions of the same general purpose, the splitting directions of the same stone dif-

Locality.	Remarks.	Rift.	Grain.	Hardest splitting direction.
E. Blue Hill.	....	....	Vert., E. & W.	....
Deer Island.	....	Vert., N. & S., parallel to joints.	....	....
Mt. Waldo.	....	On lift, par. to sheets, dipping off from Mt.	S. 75 E., par. to head joints.	....
Swanville, Waldo Co.	Regular sheets 1 to 4 feet thick.	Vert., N. & S.	Vert., E. & W., par. to head joints.	....
Lincolnville.	....	Vert., par. to vert. joints.	....	....
Harbor Qy., Vinal Haven.	Sheets, 3 to 8 feet thick.	Very good, vert., E. & W. par. to jts.	....	....
Sands Qy., Vinal Haven.	Sheets, 4 to 8 feet thick.	Vert., N.W. & S.E., par. to joints.	....	....
Duschane.	Sheets irregular.	Vert., par. to E. & W. jts.	Vert., N. & S.	In the lift.
Hurricane I.	....	E. & W., par. to main jts.	Horizontal.	....
Dix Island.	Indistinctly laminated.	On the lift.	....	....
Spruce Head.	Thick sheets.	Vert., E. & W., nearly par. to head jts.	....	....
Round Pond.	....	On the lift, or hor.	Vert., par. to the joints.	....
Hallowell.	....	Nearly horizontal, dipping to the north.	E. & W., par. to main seams.	....
Biddeford.	Sheets, 1 to 10 feet thick.	Oblique to the 2 sets of vert. joints.	Horizontal.	Parallel to main N.E. & S. W. joints.

fering widely in even neighboring quarries. Thus, in a trap quarry on Pleasant River, Maine :

"The rift or easiest splitting direction runs parallel to the east and west joints; the grain, or next easiest, north and south; while the lift, or horizontal splitting, is hardest of all."

On the other hand, in many of the granite quarries, "the rift of the stone is, as the quarrymen express it, 'on the lift,' that is, horizontal or parallel to the sheets," while the grain may be vertical, or even oblique, and an additional third splitting direction often exists. The relationship thus drawn between the division-surfaces of this stone and its cleavage-planes may be further illustrated by the table, page 33, which has been compiled from the notes on Building-Stones in Volume X. of the Reports on the Tenth Census of the United States.

Physical Characteristics of the Dolomyte.

The color of the stone, on its natural fracture, is an agreeable blue-gray, with a bright sparkling surface, diversified on the "cross-grain" plane by light gray and white lines and stripes, more or less zigzag. These plications bear testimony to the degree of condensation to which the material has been subjected during the folding of the stratum.

The first influence of weathering upon a fresh surface consists of a seasoning effect, which somewhat darkens the stone, sometimes even to a deeper bluish-gray, and decidedly hardens its surface, even within a year. Thus, while easily worked when fresh from the quarry, it soon resists the edge of a tool to a marked degree—a property probably connected with the deposit of calcium carbonate from the "quarry-water" or "sap" of the rock. Thin veins of calcite are not uncommon, carrying crystals or grains of quartz, phlogopite, rutile, etc. After long exposure of a quarter or half century, the blue-gray color of the dolomyte becomes mellowed by a brownish tinge.

The texture of the stone, and, to some extent, its density, vary with its stratigraphical position. In broad folds with gentle dip, the stone has a more slaty structure and looser texture; in the crumpled sharp folds, it assumes an increased compactness, hardness, and density. From an average specimen, in coarse powder, the specific gravity 2.853, in distilled water at 60° F., was obtained, equivalent to a weight of about 179 pounds per cubic foot of the dry stone—an exceedingly high density. This fine texture and homogeneity are further shown by the absence of cavities and "sand-holes," such as commonly mar the weathered surfaces of other marbles of western New England and of the white marble of Carrara. Another indication is the slight absorption of water, shown by the little change of color produced when the stone is wetted by rain, and

its rapid drying afterward. A determination of the total absorption of water gave for its ratio 0.148, in percentage of the weight of the stone, and for the proportion of empty spaces in its interstices, or "voids," 0.422, in percentage of its volume.

The tenacity of the stone was determined by various tests on a series of sawn cubes, two inches on a side. The average resistance to quick compression, per square inch, was found to lie at 16,118 pounds, between wooden plates; and at 20,208 pounds, between cast-iron plates. The amount of condensation of such a cube, under compression between cast-iron plates, reached 50 ten-thousandths of an inch at a pressure of 40,000 pounds, and 90 ten thousandths at 60,000 pounds, the cube finally exploding at a pressure of 80,000 pounds within a quarter of an hour. In the fracture of a bar of the stone, 6 inches long by 2 inches square, by rapid application of sufficient pressure at its middle, while supported on steel faces for a distance of $\frac{1}{2}$ inch from each end, the breaking load, calculated to a 1-inch span, was found to be 1,346 pounds for the stone on its present "bed" surface, and 1,144 pounds on its side, the lamination of the stone running with the axis of the bar. The amount of deflection in the middle of such a bar, with the pressure slowly applied in the position "on bed," reached 38 ten-thousandths of an inch at a pressure of 1,000 pounds, 61 at 2,000, and 90 at 2,250; on the side, 30 at 1,000, and 42 at 1,500 pounds.

To determine the durability of the stone, wet cubes were exposed during a winter in the open air to a series of 42 successive freezings, with alternate thaws, and a loss was found of 0.009 per cent of the weight of the stone, per square inch of surface exposed.

Microscopic Examination of the Dolomyte.

When a natural surface of the dolomyte is examined under a low magnifying power, it is found to consist entirely of crystalline grains, so closely compacted together as to be indistinguishable except by slight differences in their shades of color. Most of the grains consist of grayish-white to dark smoky-gray dolomite, but particles of brass-yellow pyrite, grayish-white quartz, and yellow scales of magnesian mica or phlogopite, can be also easily recognized. In a thin section, the following complete series of the constituent minerals was distinguished. Dolomite, in compact grains, often with a fine lining, which indicates the twinning structure. These grains varied in size from 1 to 5 mm. Calcite, in occasional compact colorless grains of similar size. Phlogopite, in minute irregular scales, blades, and fibrous grains, either colorless or salmon-yellow. Pyrite, in brass-yellow, bright grains and crystals in the form of modified cubes and octahedra,

from the size of nearly 3 mm. down to fine dust. Quartz, in irregular grains, limpid, colorless, and apparently homogeneous, often 3 mm. in length; when examined in polarized light, these are found to separate into many small granules. Besides these, there may be sometimes observed a dark-green, transparent mineral, perhaps a form of amphibole, in a few minute particles, sometimes gathered in groups, often closely associated with the scales of phlogopite. Rutile, in a few very short and dark needles, which are opaque. Iron-ochre, in rare brownish particles, sometimes seen in interstices of the other grains. Carbon (perhaps as graphite), in exceedingly minute, black particles or fine dust, scattered through the grains of dolomite in small quantity.

Instead of being homogeneous, as the mass appears in reflected light to the eye or under a glass, the thin section reveals its grains sharply divided by distinct lines of demarcation. No finer material of any kind could be distinguished between the grains, as indeed no definable interstices occur.

The practical conclusions from a study of the thin sections are as follows:

1. The stone does not consist of larger grains bound together by a visible cement. All are of pretty uniform size, and the secondary cementing process, which has been indicated by the hardening of the stone on seasoning, must be brought about by the deposit of films of some soluble material, probably calcium carbonate, introduced throughout this fine network of division-planes, and so binding all the grains into a solid mass.

2. The blue-gray color of the rock seems to be chiefly produced by the dark smoky color of a certain proportion of the dolomite grains; and these in their turn appear to owe their color to the distribution throughout their material of a small proportion of fine particles of carbon and of pyrite dust. I am inclined to attribute the bluish shade of this gray color to a play of light from the brilliant faces of the minute crystals of pyrite.

3. The quartz grains were not an original constituent of the dolomyte. They possess the structure of a chemical deposit, and fill up cavities and interstices which existed in the rock before the period of folding. During the latter process, it is evident, heated aqueous solutions, carrying silica, permeated the somewhat cellular stone, caused the formation of a little magnesian silicate (phlogopite), and filled up the cavities with solid quartz. To this soldering effect, largely produced by the quartz, the present compactness, solidity, and remarkable strength of the dolomyte are due.

Chemical and Mechanical Analysis.

In the analysis of this stone, the usual chemical methods were employed, which it is not necessary to describe in detail. A considerable part of the stone was found to be insoluble in acid, and it was desirable to ascertain the proportion in this of the insoluble minerals (quartz, mica, etc.), whose identification had already been made by the microscopical study of the thin sections. For this purpose, a considerable amount (over 9 grammes) of insoluble residue was first obtained from a large amount of dolomyte. The constituents in this (which of course contained no dolomite or calcite) were separated, through their different densities, by the usual method of mechanical analysis. The fine powder was stirred in the concentrated solution of cadmium borotungstate, until the heaviest mineral, pyrite (sp. gr. 5.0) had separated; on proper dilution the phlogopite (sp. gr. 2.8) and afterwards the quartz (sp. gr. 2.6) successively fell; and the small amount of carbon (sp. gr. 2.1) was left floating, and was separated by filtration.

The analysis of the stone is presented below in two forms: in the first with the actual chemical constituents, separated by chemical means; in the second, with the actual mineral constituents of the stone, as obtained by calculation and by mechanical analysis. In the latter statement, the first constituent, dolomite, contains a little iron, manganese, and a trace of nickel.

Analysis.

Insoluble residue	15.41
Lime	27.33
Magnesia	17.89
Ferrous oxide	.70
Ferric oxide	.34
Manganous oxide	.22
Nickel oxide	trace
Alumina	.22
Carbonic acid	37.80
Silicic acid (soluble)	.20
Sulphuric acid	.21
Phosphoric acid	.10
Moisture	trace
	100.42

or

Dolomite	67.93
Calcite	11.97
Iron-ochre	.34
Phlogopite	9.33
Quartz	8.16

Pyrite	1.37
Graphite	.24
Gypsum	.44
Apatite	.22
	100.00

As to one of the subordinate constituents of the rock, pyrite, I have considered its durability in another paper.[1] The variety of the mineral here present usually possesses a pure bright-yellow color, high specific gravity (4.99), conchoidal fracture, and a dense texture under microscopic examination—all satisfactory indications of strong resistance to atmospheric oxidation. These evidences of stability were further confirmed by its condition on the weathered outcrops of the rock, on whose roughened ledges its grains often project side by side with those of quartz, or are even found loosened but undecomposed where the rock has decayed and fallen into sand. So, too, its grains still sparkle brilliantly on the surfaces of ancient masonry, exposed over a half century to the ozonized atmosphere of the Berkshire mountain region. Similar testimony was borne by the slow and gradual decomposition of the mineral, when its crystals were subjected to the severe laboratory test of exposure to the action of the corrosive vapors from fuming nitric acid or from bromine. The mineral seems to have little to do with the disintegration of the rock, and, indeed, probably contributes to its rigidity, its great strength under compression, and the blue shade of its gray color.

The stability of the pyrite in this dolomyte layer contrasts strongly with the unfortunate frailty of the common variety which occurs in the marbles of the underlying "Stockbridge limestone" stratum. Thus, in the marble at Lee, Mass., decomposition sets in after even a few months' exposure, and produces a conspicuous and offensive brownish-red blotch, often a quarter or half-inch in diameter, around a particle of pyrite barely visible to the eye, or even long reddish streaks across the face of the marble where a few of these particles occur in a row.

The slight brownish tint assumed by the surface of the dolomyte after very long exposure to the weather seems to be due to the alteration of the colorless scales of magnesian mica into a brown color; while the pyrite generally retains its high lustre and bright-yellow color, rarely assuming a copper-red film of oxidation in closed seams occupied by moisture.

This fact seems to corroborate the stratigraphical distinction between the matrices of the mineral in the two localities; and it

[1] "On the Variation of Decomposition in the Iron Pyrites, and its Relation to Density." Ann. N. Y. Acad. Sci., III., IV., 1886-88.

is hoped that this paper may invite the attention of observers in other portions of this limestone belt to the recognition of upper calcareous members of the same series, not continuous with the main sheet of crystalline limestone.

DR. JULIEN'S paper was discussed by MR. F. J. H. MERRILL, DR. N. L. BRITTON, PROF. W. P. TROWBRIDGE, DR. H. CARRINGTON BOLTON, and the PRESIDENT.

DR. N. L. BRITTON remarked that, in a recent boring on Staten Island, the schist was, as reported, found at a depth of 600 feet. About 200 feet of glacial drift was pierced, containing boulders, below which was 200 to 400 feet of cretaceous sands and clays.

It was remarked by the PRESIDENT that the occurrence of cretaceous strata directly upon the Archæan in this locality indicated the existence here during secondary time of a region of separation between the Triassic areas of Connecticut and New Jersey.

October 24, 1887.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Ninety-three persons present.

DR. H. CARRINGTON BOLTON read a paper on

THE COUNTING-OUT RHYMES OF CHILDREN; A STUDY IN INTERNATIONAL FOLK-LORE.

[Abstract.]

Children playing out-door games, such as "Hide and Seek" and "I Spy," in which one of their number has to take an undesirable part, adopt a method of determining who shall bear the burden, which involves the principle of casting lots, but differs in manner of execution. The process is called in Scotland "chapping out" and "titting out," but in England and America it is commonly known as "counting-out." It is usually conducted as follows: a leader, generally self-appointed, having secured the attention of the boys and girls about to join in the proposed game, arranges them in a row or in a circle around

him as fancy may dictate. He then repeats a peculiar doggerel, sometimes with a rapidity which can only be acquired by great familiarity and a dextrous tongue, and pointing with the hand or forefinger to each child in succession, not forgetting himself (or herself), allots to each one word of the mysterious formula:

One-ery, two-ery, ickery, Ann,
Fillicy, fallacy, Nicholas, John,
Queever, quaver, English, knaver,
Stinckelum, stanckelum, Jericho, buck!

This example contains sixteen words; if there is a greater number of children a longer verse is used, but generally the number of words is greater than the number of children, so that the leader begins the round of the group a second time, and may-hap a third time, giving to each child one word of the doggerel. Having completed the verse or sentence, the child on whom the last word falls is said to be "out," and steps aside. In repeating the above doggerel, the accent falls on the first syllable of each polysyllabic word; a very common ending is:

One, two, three,
Out goes she (or he)!

and the last word is generally said with great emphasis, or shouted.

After the child thus "counted-out" has withdrawn, the leader repeats the same doggerel with the same formalities, and, as before, the boy or girl to whom the last word is allotted is "out" and stands aside. The unmeaning doggerel is repeated again and again to a diminishing number of children, and the process of elimination is continued until only two of them remain. The leader then counts-out once more, and the child not set free by the magic word is declared to be "*it*," and must take the objectionable part in the game.

The word "*it*" is always used in this technical sense, denoting the one bearing the disagreeable duty, or perhaps the distinguished part, in a game; no child questions its meaning, nor have we learned of any substitute for this significant monosyllable; it is not safe, however, to assert that there is no equivalent when we consider the innumerable whims of the army of children. The declaration to a child: "You are *it!*" following the process of counting out, seems to carry with it the force of a military order, and is, in many cases, more promptly obeyed than a parent's command.

Children learn these rhymes by sound alone from their playmates a few years older; though accuracy is faithfully attempted, changes are introduced from time to time, and in the course of generations the results would scarcely be recognized by the chil-

dren of an earlier period. The round game of Scandal, which is said to have furnished amusement to English literary celebrities, illustrates the way in which oral communications are distorted. Since counting-out is the main object in view, the puerile mind is probably satisfied with retaining the rhythm, the rhyme, the number of words, and the general construction, any or all of these features. So far as counting-out is concerned in the simple rhyme :

> " One, two, three, four,
> Mary at the cottage door,
> Five, six, seven, eight,
> Eating cherries off a plate ; "

it makes no difference whether we say Jennie for Mary, kitchen for cottage, apples for cherries, and picking for eating ; the general effect is the same.

A very natural corruption is that of : " One is all, two is all, six is all, seven " into " One-erzoll, two-erzoll, zickerzoll, zan " but the conversion of " bobtail vinegar" (with which the second line begins) into " Baptist minister," is a surprise. Yet the history of the English language affords continually examples equally eccentric ; the names of old taverns in England have undergone curious transformation at the hands, or strictly at the mouths, of the common people. The British tar who finds his sea-home christened " *Bellerophon,*" is not long in transmuting it into *Billy Ruffian,* a much more comprehensible and satisfactory name to him. " *L'Hirondelle,*" became in like manner *Iron Devil.*

The school-boy looks upon these rhymes as merely queer sounds and has "no compunction in making them queerer ; and his genius leads him to tack on other nonsense provided it rhymes." (Ellis.)

The number of these doggerels in use among children is far greater than commonly supposed. The speaker has collected no less than 450 current in England and America ; of these he gave about twenty examples.

He has also succeeded in demonstrating that the custom of counting-out obtains around the world among civilized and semi-civilized races, and by correspondence and personal inquiry he has collected examples in the following languages : Penobscot, Japanese, Hawaii, Marâthi, Romany, Arabic, Turkish, Armenian, Bulgarian, Modern Greek, Swedish, Portuguese, Spanish, Basque, Italian, French, Dutch, Platt-deutsch, German; and with the English above-named they number over 870.

Having established the wide distribution of the custom of counting-out, the speaker discussed the antiquity and origin

first of the practice and *second* of the rhymes themselves. He finds the practice to be a survival of sortilege or divination by lot. Sortilege was practised among the ancient heathen nations as well as by the Israelites, and he gave many illustrations of this, especially dwelling on the story of Achan related by Joshua.

The use of the lot at first received divine sanction, but after this was withheld, the practice fell into the hands of sorcerers, which very name signifies lot-taker. The doggerels themselves the speaker regards as a survival of the spoken charms used by the sorcerers of the Middle Ages in conjunction with their mystic incantations. He gave numerous examples of these charms, such as :

"Huat hanat ista pista sista domiabo damnaustra." (Cato, 235 B.C.)
and: "Irririori, ririori essere, rhuder fere,"
and: Meu, treu, mor, phor,
Teux, za, zor,
Phe, lou, chri,
Ge, ze, on. (Alexander of Tralles.)

In only one instance had the speaker been able directly to connect a child's counting-out rhyme with a magic spell ; according to Leland the rhyme beginning:

One-ery, two-ery, ickery, Ann,

above given, is a Gypsy magic spell in the Romany language.

Tylor, in his "Primitive Culture," holds that things which occupy an important place in the life-history of grown men in a savage state, become the playthings of children in a period of civilization ; thus the sling and the bow and arrow, which formed the weapons of mankind in an early stage of its existence, and are still the reliance of savage tribes, have become toys in the hands of all civilized children at the present day. Many games current in Europe and America are known to be sportive imitations of customs which formerly had a significant and serious aspect.

Adopting this theory, the speaker holds that games of chance are in part survivals of the practices of the sorcerer, using this word in its restricted and etymological meaning ; he maintains, further, that the spoken and written charms originally used to enforce priestly power, have become adjuncts to these puerile games, and the basis of the counting-out doggerels under consideration.

The idea that European and American children engaged in "counting-out" for games are repeating in innocent ignorance the practices and language of a sorcerer of a dark age, is perhaps startling, but can be shown to have a high degree of prob-

ability. The leader in counting-out performs an incantation, but the children grouped around him are free from that awe and superstitious reverence which characterized the procedure in its earlier state. Many circumstances make this view plausible, and clothe the doggerels with a new and fascinating interest.

Following out this idea, the speaker showed many analogies between ancient customs and present games of children, in the use of the pebble, of the inverted cap, in the design for which the counting-out is applied, etc. He showed the similarity in all languages of the rhythm, admixture of gibberish with words having meaning, and in the use of numerals, and claimed for these analogies indications of antiquity.

He indicated the modern origin of some of the rhymes current in America; as for example:

> One, two, three, four, five, six, seven;
> All good children go to Heaven;
> All bad children go below
> To keep company with Guiteau.

He showed also the geographical sources of some of these doggerels, and the influence of environment on them.

In conclusion he referred briefly to the Anglo-Cymric Score, popularly supposed to be an "Indian" method of counting, but in reality of Welsh origin, as shown by Ellis.

Remarks were made by Mr. L. E. Chittenden, Prof. Frederick Stengel, and by the President.

October 31, 1887.

Stated Meeting.

The President, Prof. J. S. Newberry, in the chair.

Sixty-five persons present.

Announcement was made that the *Local Committee, A. A. A. S.*, had been invited to attend the next meeting of the Academy, and that a reception and collation would be given in their honor.

Prof. J. S. Newberry gave an address on

WESTERN COLORADO—ITS SCENERY, GEOLOGY, RESOURCES, AND FUTURE.

(Illustrated with lantern views.)

November 7, 1887.

REGULAR BUSINESS MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

About three hundred persons present, in the East Lecture Room of the Library Building, Columbia College.

The Report of the COUNCIL made the following recommendations:

I. The payment of certain bills.

II. That the Recording Secretary be paid an annual salary of three hundred dollars, the duties of the office to include the editing of the Transactions.

III. The election of Mr. H. F. J. PORTER as Resident Member.

IV. The election of the following members as *Fellows:*

PROF. J. A. ALLEN,
DR. T. F. ALLEN,
HON. ADDISON BROWN,
HON. EDWARD COOPER,
MR. C. F. COX,
MR. ANDREW E. DOUGLASS,
MR. P. H. DUDLEY,
MR. S. LOWELL ELLIOT,
MR. WILLIAM L. ELSEFFER,
DR. J. J. FRIEDRICH,
MR. L. P. GRATACAP,
MISS F. R. M. HITCHCOCK,
PROF. CLARENCE KING,
DR. R. H. LAMBORN,
PROF. G. W. MAYNARD,
MR. JOHN MCDONALD,
MR. F. J. H. MERRILL,
MR. CHARLES E. PELLEW,
DR. LUCIUS PITKIN,
MR. J. F. POGGENBURG,
DR. HENRY H. RUSBY,
DR. S. HANBURY SMITH,
REV. J. SELDEN SPENCER,
PROF. W. LE CONTE STEVENS,
PROF. J. J. STEVENSON,
DR. CHARLES F. TAYLOR,
DR. WILLIAM J. YOUMANS.

V. The election of the following persons as Honorary Members:

Prof. Alexander Agassiz, Cambridge.
Rev. J. H. Dallinger, London.
Prof. W. H. Flower, London.
Prof. S. P. Langley, Washington.
Dr. Joseph Leidy, Philadelphia.
Baron Ferdinand Von Muller, Melbourne.
Prof. Louis Pasteur, Paris.
Sir Henry Roscoe, Manchester.
Prof. H. F. Rosenbusch, Heidelberg.
Prof. John Tyndall, London.

The items of the report were severally adopted, excepting No. IV., which was laid over one month, under the rule. The bills were ordered paid; and the candidates for Resident and Honorary membership were elected by formal ballot.

An invitation was read from the Field Committee of the Torrey Botanical Club to the members of the Academy to join in their Annual Field Excursion, with the Staten Island Natural Science Association, upon election day, November 8th, 1887.

Mme. Alice D. Le Plongeon delivered a lecture, illustrated with lantern views, upon

EASTERN YUCATAN, ITS SCENERY, PEOPLE, AND ANCIENT CITIES AND MONUMENTS.

(Abstract.)

The natives of Yucatan are in many respects very interesting people; they are the descendants of the Mayas, anciently the most civilized of all Americans. At the time of the conquest, 1541, they became slaves, remaining so for many years, and when finally made free citizens, they suffered just as much oppression. A rebellion, in 1847, was the result, and a few thousand men made themselves free, waging war ever since against the white inhabitants.

All the field laborers are natives. They are hard-working, moral people. The comforts of life are almost unknown to them. The scantiness of their apparel awakens the pity of occasional tourists, but the climate makes much clothing un-

desirable, and those children of nature consider their feelings more than their appearance. They are not educated, because the white people fear that instruction would make them ambitious, unwilling to work in the fields and to carry burdens.

Among the many ancient cities scattered over the peninsula is Mayapan, in utter ruin, it having been destroyed by the natives themselves in the year 1447, when king Cocom, the last of his dynasty, was put to death with his sons, because he was a tyrant and introduced Mexican mercenaries to support him. Cocom's skull was not preserved as those of his ancestors had been. After death, their heads were severed and boiled till the flesh came from the bone. The posterior part of the skull was then sawed off, the front being preserved with the jaws and teeth. Upon this they moulded a sort of putty, imitating in appearance the flesh that had been removed and making an exact portrait of the deceased. These faces were kept in private chapels and regarded with great reverence. But the last of the Cocoms was blotted out with the place in which he lived; the city being sacked and burned when the king and his sons were killed.

Dr. Le Plongeon discovered at that place a gnomon that had served to make astronomical computations.

Aké, 24 miles east of Merida, and said, though erroneously, to be the site where the Spaniards won the first battle with the natives, is a place of particular interest, because of the chronological record, called *Katuns*. These stand on an oblong structure consisting of three superposed platforms, the upper projecting over the one beneath. On it there are 36 columns, four feet thick, formed of roughly hewn stones, placed one above another. These are the Katuns. The people of Yucatan divided their time into eras of 20 years, subdivided into periods of 4 years, each year consisting of 365 days. The era of 20 years was a *Katun*. At the conclusion of each Katun they put a hewn stone upon those already piled up. There seems also to have been a great era of 180 years, for in each of these columns there are 9 stones which, multiplied by 20, give 180. People reckoned their age by these stones. A man 60 years old would say: "I have three stones of years." On the summit of this structure at Aké there are 3 rows of columns, 12 in each, making in all 324 stones. These, multiplied by 20, give us 6,480 years from the time the first stone was put in place until the 36th column was crowned, which may, for aught we know, have been long previous to the 16th century, when the Spaniards arrived. We are therefore safe in saying that these terraces were built at least 7,000 years ago, for to the 6,480 we must add 369 years, elapsed since the conquest. We may also remark that these columns standing as they are would show

that, during all that time, the country has been as free from earthquakes as it now is.

Fifteen miles east of Aké is the historic city of Izamal, famous long before the conquest as a resort of pilgrims, these even coming from Xibalba, now known as Chiapas and Guatemala. Many of the ancient monuments at Izamal have been destroyed to build dwellings and pave streets; but there are still some large mounds that are a source of wonder to the inhabitants. One on the north of the square, has a gradual ascent of broad steps on the south side, and an almost perpendicular one on the north. It is built on a very extensive terrace 34 feet high, and 272 feet wide. The mound itself is 34 feet high, its summit being 68 feet above the ground. The upper platform was nearly 23 feet square, and upon it once stood the temple of Kinich-kakmo (fiery macaw with eyes like the sun). This goddess is said to have descended from heaven in the form of a macaw every day, and set fire to the offerings on her altar.

At the base of the monument, on the east side, Dr. Le Plongeon discovered a small opening, and, in the hope of finding chambers, penetrated to a distance of about 30 feet, but a dry stone wall prevented further progress. To the north he perceived an aperture through which he succeeded in passing, then found that he had no room to stand upright. On all-fours he advanced about 45 feet, making his way among immense blocks of stone that form the foundation of the structure. Again the way was blocked. Retracing his steps, he noticed that a strong current of air came through one part of the stone wall. Accordingly he had an opening made there, and penetrated about 75 feet in a westerly direction. He had to crawl, and his back touched the stony roof above. At the end of that small passage, there was a place where he could sit upright. To the left there was an opening almost blocked with earth that had sifted through between the stones. The space was too small to admit his shoulders, but looking through he saw a chamber about 13 feet long and ten wide. On its south side there was an entrance to a subterranean passage, leading in the direction of another large mound.

On the west side of the square of Izamal stands a mound called by the natives *Kabeel* (the working hand). It was adorned with a frieze ornamented with stucco figures in high relief, representing human sacrifices, and surrounded by inscriptions, some of which have been interpreted by Dr. Le Plongeon.

Among the ruins of the city of Chichen Itza, a very ancient mausoleum was opened by Dr. Le Plongeon, and many curious things brought to light. In a large urn were the cremated remains of a certain prophet named Cay, who was deified after

death. Within the tomb where his ashes reposed, various objects of the temple over which he presided had also been placed; conoidal pillars, all painted bright blue and red, and twelve large, exquisitely sculptured snake heads, also painted in bright colors, as well as a large statue of remarkable interest, representing a man about six feet tall.

The PRESIDENT announced a reception and collation, to be given immediately after adjournment, in honor of the Local Committee for the New York meeting of the American Association for the Advancement of Science.

November 14, 1887.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Forty-two persons present.

MR. GEORGE F. KUNZ exhibited and described

MINERALS FROM FORT GEORGE, NEW YORK CITY.

(Abstract.)

A very interesting series of minerals was obtained during the past few months at the rock excavations for the Old Morris Home, at Fort George, near the end of the cable road, New York Island. They were as follows:

Rutile, in tetragonal prisms two inches long and one-eighth of an inch in diameter, perfectly terminated with the simple pyramid 1. The surfaces are bright, although not polished.

Titanite, in yellow crystals implanted on ripidolite, and only partly transparent. A few were light green. The crystals measured one-fourth of an inch across and one-eighth inch in thickness, and resembled those from Tavetchthal, Switzerland.

Columbite, one crystal imbedded in orthoclase, which measured one inch in length and one-fourth inch in diameter. In color it is black and the crystal is somewhat broken. The prismatic faces are quite distinct, but the terminal planes are imperfect from breaking. Also one crystal in quartzite, equal to any from Standish, Maine, measured $\frac{3}{8}$ inch in length and $\frac{1}{2}$ inch wide. This is the first known occurrence of Columbite on this island.

Beryl, in crystals, by far the largest ever found on the island.

Although the largest is only one-half of a crystal, it measures over four inches across the prism. Another measures three inches in width and two and one-half in length, and is perfectly terminated with the O plane. The others were one inch in diameter and from one to two inches in length. One mass of rock ten by eight inches contained seventeen beryls from one-fourth to one inch in diameter. They were all found in a coarse granite in which were also imbedded beautiful almandite-garnets from one-eighth to one-fourth inch in diameter, but very bright, one beautiful flattened crystal of transparent garnet was found between plates of muscovite.

Muscovite, crystallized out and implanted on orthoclase, two of these crystals measuring ten inches across. They were symmetrically arranged. Cleavages showing beautiful hexagonal markings were also found.

Orthoclase, one crystal which was broken and without pyramidal faces, measured six inches across.

Washingtonite, in plates two inches square and one-eighth inch thick, penetrating the orthoclase.

Epidote in crystals, 1½ inches long, ½ across, showing faces, –1*i*–1– and *ii*.

Mr. Kunz also exhibited a photograph of the "Great Orange Diamond," which weighs ten carats more than the famous Koh-i-nur. Found at Kimberly, South Africa.

Mr. James F. Kemp presented a paper on[1]

THE GEOLOGY OF MANHATTAN ISLAND.

Manhattan Island is about thirteen miles in length, from the Battery to Kingsbridge, and of a general width of two miles below Harlem, and three-quarters of a mile above. It is inclosed between the Hudson River on the west, the East River, Harlem River, and Spuyten Duyvil Creek on the east and north. The direction or trend of its axis is N. 40° E. by the compass, which is somewhat wide of the true meridian, as the city avenues are recorded as N. 28° 58½′ E., and differ but slightly from the strike of the rocks.

The superficial area is approximately twenty square miles; the population of the island, according to the census of 1880, is 1,163,673.[2] The thickly settled portion, however, lies below 59th street, and on this area, except at its northwest corner,

[1] The paper was read, in the absence of Mr. Kemp, by Dr. N. L. Britton.

[2] Miscel. Doc. 1st Session 47th Congress, Vol. 24.

there is scarcely a vacant lot. From 59th to 110th streets, Central Park and the region lying adjacent to it, are but sparsely settled; but between 110th and 130th streets there is a triangular level valley, having Harlem at its base, and Manhattanville at its apex. North again, almost to the end of the island, the rocks prevail, and the country is open, although building is rapidly progressing, with quickened transit and local improvements. At 204th street, there is another cross valley and the small suburb of Inwood. The geological formation of the island has admirably adapted it to be the site of a commercial metropolis. Its miles of water front are nearly all suitable for wharfage, and border either on deep channels or shallow ones which can be deepened as they become needed; while at its southern extremity is a broad, deep bay forming one of the finest harbors on the coast.

Except in the upper portions, the general surface has been "improved" out of all resemblance to its original exterior; but enough observations and descriptions remain to restore it. From the Battery to 16th street or thereabouts, the surface consists of drift, which formerly rose in irregular hills, of varying height. At 16th street and the East River, the gneiss first outcrops and runs in an irregular line across to the Hudson. The gneiss continues, covered here and there with patches of drift, until we reach the cross valley called by Dr. Gale (Mather's Report) the "Manhattanville depression," which extends from 94th street and the East River to 130th street and the Hudson, as outlined on the accompanying map. This valley is filled in with drift, as is the Inwood depression further north. Between them, the gneiss outcrops again as a rough ridge. Beyond Inwood, the northwest corner is gneiss; the northeast is limestone, called Kingsbridge marble.

The formation will be described in detail under the three divisions:—The Drift, The Gneiss, The Limestone.

The *Drift* will be considered first, as it is of least importance from a structural point of view. It will be taken up under the divisions Alluvium and Drift Proper.

By *Alluvium* is understood the very recent and still forming deposits of the rivers, consisting of a soft black mud which forms the beds of their channels and the marshes or meadows of the water front. There formerly was a swamp at the lower end of Broad street, another at the lower end of Maiden Lane, another at Ferry street, where now is the leather district which to this day is always spoken of as "The Swamp;" another began at Rivington and extended a mile north with a width of half a mile; at the foot of 30th street on the Hudson was still another, now, like all those mentioned, covered with made ground and buildings.

Along the western shore of the Harlem River there is a border of salt marsh through its entire length, except where the rocky shore at and for a mile above High Bridge projects into the river. Here the process of formation is well illustrated. The tide rises with its load of sediment, halts for a time, depositing it, and retreats. The coarse marsh grass is continually edging up and as the deposit rises high enough it seizes and holds it with a tough mass of interlacing roots. So far as my observation goes, there is no line of demarcation between the meadows and the beds of the rivers. That of the Hudson consists of a stratum of soft mud known as silt, which rests upon sand or rock. It weighs about 100 pounds to the cubic foot, is unstratified, and at the top soft, but lower down becomes tougher and more compact so as to be cut into blocks when excavated. Although its deposition would seem to resemble that of clay, it differs from clay in several important particulars.[1] Gravel and filling placed upon it gradually sink through. When mixed with water, it readily forms a thin liquid emulsion. Its depth across the river at 42d Street varies from 25 to 40 feet.

As the general level of the land in this vicinity has been shown to be slowly sinking[2] it is probable that this river and meadow alluvium is on the increase. Its very presence in the river channels, themselves excavated in gneiss, proves that the rivers, or rather that the land, was formerly at a higher level. This conclusion will be reinforced further on by the testimony of the drift.

Drift.—By this is understood the mixture of sand, boulders, clay, and gravel, which, sometimes locally stratified, sometimes indiscriminately mixed, forms the covering of the rocky foundations of the island. As shown on the map, it occurs in three chief localities; first below 30th street; second filling the Manhattanville depression, and third filling the Inwood depression. It also occurs, as stated above, in patches of varying size quite generally over the area mapped as gneiss. Its structure has been shown by street-cuttings through the hills and by well-borings. The structure varies with different hills. In some it is a simple pile of earth and boulders without traces of sorting. The boulders are round and water worn and are much used as paving in the less travelled streets. Trap, like the Bergen Hill, predominates, but there are representatives of nearly all the formations north.[3] Occasionally the drift affords a bone or tooth. In the

[1] Vide Proc. Am. Assoc. Civ. Eng., Vol. IX., p. 256. Paper on the North River Tunnel.

[2] Vide Pop. Sci. Monthly, Vol. XIII., p. 652.

[3] A list is given by Mr. Issachar Cozzens in "A Geol. Hist. of Manhattan or N. Y. Island." N. Y. 1843, p. 73.

Columbia College collection there is a Mastodon tooth from that of Westchester Co., just across the Harlem River, and a bone is mentioned in Cozzens, p. 75. In other hills there was some local stratification into clay and sand and gravel beds, and at the 42d street reservoir hard pan was met with. In the Manhattanville depression the surface is quite level and is diligently tilled by the market gardeners.

The following sections exhibit the sub-surface structure with considerable thoroughness, and cover the lower part of the city. They have been obtained from Mather's Report, 4th Dist. N. Y. S. Geol. Surv., pp. 135 ff.; from a paper by I. H. Russell on the Geol. of Hudson Co., N. J., Annals, N. Y. Acad. Sci., vol. II., pp. 27 ff.; and by personal inquiry. The classification into alluvial, quaternary, and drift is that of Prof. Mather. It is largely arbitrary and not of general application, as a comparison of the sections will show.

Ave. D and Tenth St. Made earth, 6 feet; marsh mud, 10 feet (alluvial); quicksand, 12 feet; shore sand and gravel, 53 feet (quaternary); hard pan, 6 feet; coarse gravel, 3 feet (drift); total, 90 feet to rock.

Ave. D and Seventh St. 100 feet to rock.

Ave. D and Fifth St. Made earth, 6 feet; marsh mud, 10 feet (alluv.); quicksand and gravel, 65 feet; gray clay, 15 feet (quat.); total to rock, 96 feet.

Ave. D and Houston St. To rock, 96 feet.

Lewis Ave. and Seventh St. To rock, 93 feet.

Lewis Ave. and Houston St. To rock, 94 feet.

Allen and Hester St. An old well, 40 feet; quicksand and gravel, 20 feet; clay, 2 feet (quat.); coarse gravel and sand, 5 feet (drift?); to rock, 67 feet.

Foot of Jefferson St. Diluvium, 10 feet; stratified sands, gravel, and clay, 40; total, 50.

Rivington and Columbia Sts. Old well, 20 feet; quicksand, 10 feet (alluv.); marsh mud and clay, 20 feet; gray clay, 10 feet (quat.); total to rock, 60 feet.

St. Francis Hospital, Fifth St. 100 feet to rock.

All of these except the last three are located on an old salt meadow which was filled in, before or about 1840, with drift from the street cuttings inland, and soon became one of the most densely inhabited quarters of the island. This accounts for the made ground, followed by marsh mud and the drift proper.

Broad St. Made ground, 4 feet; yellow clay, 6 feet; gravel and qtz. sand, 19 feet; gray clay, 10 feet; total, 39 feet to rock.

Trinity Church. Diluvial gravel and sands, 26 feet to rock.

Washington Market. Made earth, 10 feet; river mud, vegeta-

ble matter, sands, clays in alternate strata, 50 feet; sand and gravel, 10 feet; total, 70 feet.

College place. Diluvium, 20 feet; stratified sand and gravel, 60 feet; total, 80 feet.

Fulton Market. Made ground, 15 feet; strat. sands, blue clay, and river mud, 115 feet; total, 130 feet.

"Hall's Hotel," north of last. The same, ending with a bed of gravel, 126 feet to rock.

City Hall. 90 feet to rock.

New Church St. 86 feet through quicksand.

Herald Building. 40 feet (rock?).

Western Union Building. 24 feet (rock?).

Centre and Reade Sts. Coarse gravel, 30 feet; rock not reached.

Tombs. Made ground, 40 feet; black mud, 30 feet; blue clay, 5 to 10 feet; gravel to rock, over 75–80 feet.

Grand and Wooster Sts. Made ground, 40 feet; mud, clay, sand, and vegetable matter, 20 feet; blue clay, 6 feet; coarse sand and gravel, 6 feet; to rock, 72 feet.

Bleecker St. and B'way. Strat. sand and gravel, 42 feet; rock.

Perry and W. 11th St. Sand, 40 feet; red clay, 23 feet; to rock, 63 feet.

35 Union Square. 23 feet to rock.

415 E. 54th St. 10 feet sand to rock.

99th St. and Second Ave. Made ground, 8 feet; dock mud, 18 feet; sand, 12 feet; total, 38 feet; rock?

The great depth of made ground (40 ft.) at the Tombs, is due to the former existence on its site of a pond or quagmire, known as the Collect, in the bottom of which was found a peat, which, strangely enough, was impregnated with salt.[1] This would indicate that it was formerly open to the rush of the tides, as the saline marshes are formed elsewhere. The peat had butternuts and acorns mixed through it. The drift hills of this lower part of the island attained, in one or two instances, a height of 100 feet above the street, but in general were 25 to 50 feet. They did not differ from the strata beneath them, except in the absence of river mud. The question thus naturally arises, whether or not the entire drift area, or indeed all the island but the gneiss hillocks, was once covered as high as this, and subsequently cleared by erosion. The deposit of the glacier and its flood may have been thicker yet, but, at all events, it is certain that the island must have been 100 feet lower, to bring the highest drift summit under water. And, further, the subterranean strata are 75 feet thick under this hill,[2] largely made up of sand

[1] Cozzens, p. 27.

[2] The hill was on the corner of Grand and Orange streets, not far from the section at Grand and Wooster, on which the conclusions are based.

and gravel, the deposit of a swift current, and therefore of a shallow one. The rock must have been 50 feet nearer the water level at least, during the deposition, then to have sunk until 175 feet of sedimentary strata rested on it, then to have been elevated until 100 feet and more projected above the water. If the proposition that the surface is now sinking again (see above under alluvium) be true, the island must be beginning a second great cycle of depression, to be followed, perhaps, by another elevation. The conclusion is irresistible that this island, and naturally the neighboring country, has undergone marked changes since the glacial epoch, and that during, or immediately after that epoch, it stood higher than it does now.

The sections on the map across the drift area are generalized from the data given above.

The division called "Gneiss" above will be taken up in detail under the headings, "Gneiss," "Granyte," and "Less Important Rocks."

Gneiss.—The gneiss formation is made up of a series of rocks that vary from mica or hornblende schist through all intermediate grades or varying combinations of the component minerals to a hard, heavy-bedded quartzose gneiss. They are all more or less perfectly stratified and exhibit the evidence of bedding most completely, but are cut across by granite veins and hold granite interbedded with them.

1. *Mica Schist.*—This rock consists almost entirely of a mica, either muscovite or biotite, whose crystals are held together by a cement of quartz. It is stratified, of small coherence and disintegrates easily. The mica crystals lie parallel to the bedding, their easy cleavage being the weak point of the rock. The excessive mica is what ruins the rock for building purposes, as it makes it impossible to break it across the bedding with any certainty. The schist is the weak point of the rocks for another reason. Being of more open structure, it is the most accessible place of attack for disintegrating water, and, where weathering has advanced to any extent, the schist has been the first and most extensive sufferer. Where the strata are crumpled, the schist has often been forced into fine wrinkles or waves whose amplitude is as small as an inch. It is more abundant on the east side of the island than the west.

In the district between Fifth and Fourth avenues, 49th and 57th streets, kyanite is found in considerable quantities replacing the mica and forming a kyanite schist, but it is of no great importance or extent.

2. *Micaceous Gneiss.*—As the proportion of mica decreases the rock becomes harder and more coherent, graduating into

micaceous gneiss. The layers are coarser and when contorted do not exhibit such fine crumplings as the schist.

3. *Gneiss.*—This is a dull gray quartzose rock, occurring in thick and thin beds. It is most characteristically shown when taken in sections of considerable extent. On a hand specimen it appears simply as a structureless quartzose mass. It is often interstratified with the schist, giving an alternation of hard and soft layers. It contains some feldspar and mica, but quartz is the prominent constituent.

The gneiss in general sometimes shows a tendency to break up into large irregular rhombohedra or inclined prisms from cracks or cleavage planes whose larger angle is about 105°. These peculiar volumes often give a vertical face, a "step" structure. They are well shown at the north end of Tenth avenue and at the foot of 50th street, East River.

Hornblende offers a close parallel to the mica, but is very much less abundant. There is a hornblende schist which is almost entirely formed of that mineral. It lies in flat crystals, bedded parallel to each other, so that it cleaves in thin masses. Indeed, in the early days of the city an attempt was made to quarry it as slate. Cozzens, p. 15, describes the hornblende rock as slate, and the name was not inappropriate. But all attempts to use it for economic purposes were failures. Hornblende schist graduates into hornblendic gneiss and massive hornblende. They all lie interbedded with the gneiss in thick and thin layers, but structurally differ little from it.

The hornblendic rocks exhibit their peculiar property of splitting up from the influence of the weather or water into longitudinal columns, so that an exposed surface seems like an end view of a pile of irregular logs.

The gneiss also contains many segregated quartz veins, but I have not noticed any of considerable size on the island. The quartz is ferruginous, vitreous, and milky.

Granyte.—The western side of the island is largely made up of granyte, but it appears everywhere to be a veinstone, either filling segregated veins parallel to the bedding or cross fractures. Its structure varies from fine compact, to a very coarsely crystalline mixture of feldspar in large cleavage masses, mica in broad leaves and quartz as a matrix. The feldspar is generally orthoclase of the pink variety, but plagioclase is by no means rare, and often exhibits the twin structure with great distinctness. The close-grained granite has been, and is still quarried for building stone whenever a street is cut through it, and is much superior to the gneiss.

The segregated veins are exhibited in many places. Along the line of Tenth avenue, 48th to 54th streets, there is the

largest one that I have seen; although the contact is not shown, as building or street pavement hide it, there is a width visible of at least 100 feet. That granyte may be segregated, or from no different source than the gneiss, is shown at 95th street and Fourth avenue where there is a boss or knob of granite, 6 ft. x 4 ft. in gneiss, apparently an individual lump. Granyte also fills fissure-veins and cracks that run across the bedding at all angles. At Tenth avenue and 82d street, there is one 6 feet wide, rising 15 feet above the street, and at the north end of Tenth avenue there is one 8 feet wide, almost parallel to the bedding and visible from a long distance, as its white surface runs like a broad ribbon across the darker gneiss. Along the river path, south of High Bridge, there are several at a small angle with the strata, 6 inches wide, but traceable for 50 yards or more. Some of the granite veins are very curiously and beautifully banded. Next the walls, on each side, is a stripe of mica whose crystals or leaves all point in towards the middle of the vein, while the interior is filled by the veinstone. This is not compatible with an eruptive filling, nor is the fact that the contact is everywhere sharply defined with no injury to the gneiss.

The published descriptions of the island illustrate very well the change in the accepted geological idea of granyte. The prevailing opinion now is in favor of a metamorphic origin. But in the sections of the island, by Mr. Cozzens (1843), an interior of granyte is always represented as supporting the gneiss, and occasionally welling up through it as veins.

The granyte varies sometimes to a pegmatite, and sometimes has its feldspar a plagioclase. The feldspar weathers to kaolin and the quartz drops away to sand. This is shown in a decomposed vein just over the Eighth avenue park wall, a block or two below 110th street. There is a broad outcrop of a disintegrated and kaolinized vein, the solid portion being too deeply buried to be visible.

Throughout the gneiss, particularly the micaceous variety of the east side, are found masses of a green plagioclase, presumably oligoclase, sometimes six to eight inches in diameter. It contains pyrite, calcite, and occasionally a well-formed crystal of tourmaline. Irregular deposits or segregations of orthoclase also run through the gneiss, varying from brick-red to lighter shade. It appears to fill the irregular, jagged cracks from disturbance. Tourmaline is very generally distributed through the granyte, often in large but very brittle prisms, and the mica occasionally is in very broad plates or leaves.

Less Important Rocks.—A very curious and interesting rock[1]

[1] Mather's Report, p. 582.

forms a bed running from 54th street and Tenth avenue to 60th street and the Hudson River, where it goes under the water. In parts it is a mass of fibres radiating from centres, but elsewhere it becomes serpentine or talc. The fibrous portion has been called hydrous anthophyllite by Dr. Torrey, and classed with the amphibole group by Dana,[1] and pronounced to be the result of the alteration of an asbestiform tremolite. Analyses are given in the Annals Lyc. Nat. Hist., VIII., 123, and in Dana's Min., p. 242. The bed sometimes becomes a blackish serpentine with calcite distributed, forming ophiolite. I have been unable to find an outcrop of the bed, as it has been built over and covered up, although stray pieces and boulders are to be found along the river.

The preserved descriptions indicate it to have run throughout its length close beside a granite vein. It is recorded also that boulders of the anthophyllite were formerly distributed very generally over the island, and in Mt. Vernon it has been collected by Mr. Fowler. One is inclined to conjecture, not without reason, yet with no positive proof, that the deposit must have been more extensive than is outlined above, and have been eroded away, or that all of its localities have not been recorded as yet.

Epidote.—In the region about Fourth avenue and 101st street, epidote occurs in deposits of considerable size, forming a rock. It is a granular, sandy mass in parts, interstratified with hornblende in thin layers, and in other parts of a very firm compact character. The fissures are lined with a coating of crystals, which are small but of considerable brilliancy. I have seen it elsewhere as a mineral in fissures, but here it is abundant enough to be called a rock, possibly what is called by Dana, epidosyte.[2]

Limestone.—The northeast corner of the island consists of limestone, known as "Kingsbridge Marble," and it outcrops elsewhere further south, but in small quantities. It is firm and massive, and in all stages of decomposition down to calcareous sand. The massive sometimes weathers into a saccharoidal form before it crumbles to sand. The color of the limestone is a dirty white. It has been employed as a building stone for one or two large dwellings on the Kingsbridge Road, but is not well adapted for such a purpose, as it is weak and falls an easy prey to the weather. I have seen statements that it is dolomitic,[3] but finding no analyses, I have analyzed it myself. Two specimens from

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[1] Dana's System Mineralogy (1877), p. 242.
[2] "Man. Min. and Lith.," p. 453.
[3] Cozzens, p. 15, states that he obtained 28% $MgCO_3$.

the western outcrop of the Inwood cross valley, massive and unweathered, gave the following results:

	SiO_2	$(Fe_2O_3Al_2O_3)$	CaO.	MgO.
No. 1.	3.14	1.34	37.23	10.26
No. 2.	3.4	0.98	39.60	10.33

A sample of crumbling weathered sand from an adjacent outcrop gave

No. 3.	9.15	3.5	27.36	8.73.

In No. 1 and No. 2, the percentages as $CaCO_3$ and $MgCO_3$ are:

	$CaCO_3$	$MgCO_3$
No. 1.	66.4	to 21.44 and
No. 2.	70.7	to 21.69.

The rock falls far below the $MgCO_3$ percentage of a typical dolomite, and would be called a magnesian limestone. The third analysis indicates that the lime is more soluble or susceptible to the attacks of the weather than magnesia, one-third to one-fourth of the CaO having gone and only about one-sixth the MgO, a ratio of about two to one. This is corroborative of the accepted opinion that the presence of magnesia in a mortar makes it more enduring. In the early part of the century quicklime was made from it, but it was slow in slaking and was finally abandoned; but when time was allowed, it is said to have made a very strong and durable cement.

The limestone contains fine crystals of white pyroxene which are obtained by digging in the disintegrated portion. They never have terminations so far as I have seen, but show excellent prismatic faces. The limestone also contains nodules of fœtid quartz and felspar.

The limestone is interbedded with the gneiss, and at 122d street and Lexington avenue[1] to Fourth avenue, it is associated with a calcareous gneiss which has the structure of gneiss, but effervesces. Also across the Harlem River near the Mott Haven Station, there is an outcrop that partakes very much of the character of gneiss. As the sections show, the rocks are very closely interbedded and fade into each other. Now, as the gneiss is universally acknowledged to be an altered sediment, the conclusion seems unavoidable that they owe their difference simply to the chemical difference of the sediment, which was due to altered conditions of deposition, quite analogous to the hornblende beds, the granite beds, and the micaceous beds which together form the series. So little can be positively affirmed, however, of the

[1] Mather's Rep.

past history of these beds that any particular or minute description of their process of formation must necessarily be, as yet, largely conjectural. But they are undeniably of the same geological age as the gneiss, a consideration of great importance in determining it, and which will be referred to again. The extent of the limestone area is marked out on the map; for it I am almost entirely indebted to the article on the "Limestones of Westchester Co." by Prof. Dana, *Amer. Jour. Sci.*, V. XXI. (1881), p. 425, who has described the beds on the island with great minuteness.

Structurally the island is a long ridge of gneiss, cut off from the mainland by the valley of Spuyten Duyvil Creek, and broken at Inwood and Manhattanville by two cross valleys, and in the upper portion somewhat divided longitudinally by small valleys. The gneiss is prolonged to the north in the main-land and runs into the Highlands. To the southward it appears in Bedloe's Island[1] and Staten Island.[2] To the west it disappears under the Hudson, reappearing only opposite the southern portion in a small outcrop in Jersey City,[3] now graded away. Opposite the northern portion are the Palisades with their trap and sandstone. The contact is not visible, being under the river. To the east the gneiss runs under the East River and outcrops in Astoria and Long Island City, and on Blackwell's Island. But south of these it has not been found. It is probable that it underlies the drift on which Brooklyn is built, but at too great a depth to be reached by any excavations yet made.[4]

The island is thus a narrow gneiss ridge, with triassic trap and sandstone on the west, and very well connected north and south with the gneiss of the mainland. As to the age of the rocks there is wide diversity of opinion. The island is an outlying post in a geological battle ground which has been fought over with great vigor, as the last thirty years or more of *Silliman's Journal* abundantly show. Nor is the discussion at rest yet. Briefly, they are pronounced by the one side to be Archæan, and part of a connecting ridge between the Appalachians and the mountains of New England. Dr. T. Sterry Hunt, the most prominent advocate of this school, classes them with his Mon-

[1] Pop. Sci. Monthly, Vol. XIII., "Geol. N. Y. Island," by Dr. J. S. berry.

[2] Ann. N. Y. Acad. Sci., Vol. II., p. 161. "Geol. Richmond Co.," Dr. N. L. Britton.

[3] Ann. N. Y. Acad. Sci., Vol. II., p. 27 seq. "Geol. Hudson Co.," I. H. Russell.

[4] Russell (op. cit.) gives some results of test borings for the Brooklyn Approach of the East River Bridge.

talban system[1], and indeed the description of the typical Montalban series[2] would make a very good description of the island. Macfarlane[3] likewise pronounces them Montalban. But the objection is made by the other side that similarity of rock structure does not imply identity of age, and that the question must be decided by stratigraphical considerations. Working on this line, Prof. Dana has sought to establish the connection between these schists and the fossiliferous Lower Silurian beds further north, and to show that they have simply been carried further in the process of metamorphism.[4] The crucial test of the conclusion is the connection between the two at Fishkill, which is beyond the limits of this paper.

Prof. Stevens[5] pronounces them Taconic, and makes a separate group, the "Manhattan Group," for their accommodation. But they differ in no important particular from the mainland and do not deserve the distinction.

The question narrows therefore to the problem of local configuration. The sections on the map show the character of the bedding.[6] The prevailing strike of the rocks is, by the compass, N. 40 E., and the dip varies from great contortions along the line of Third and Fourth avenues, to a general angle of 45° W. in the eastern part, and to verticality in the western. Sections L. M. and I. K. have been partly taken from Dana,[7] but some attempt is made to indicate surface configuration, which his sections do not show. It is interesting to note how the fold, which is shown in the limestone at 138th street, is continued in the contortions to the south, shown in section G. H., and doubtless might with truth be exhibited in the other sections, but it was not possible to get local observations, owing to buildings. It is very possible that it would be true to map other folds. Prof. Stevens gives a section in the Lyceum *Annals*, Vol. VIII., p. 108 seq., in which four or five synclinals are suggested and a bed of limestone assumed under the Hudson. But this did not seem to me to be warranted by the facts. If the original stratum has been doubled up so many times, it could only have been very thin when horizontal. Now much of its upturned edges must have been eroded, and if we supply but very little and imagine the folds flattened out, the bed would cover a good deal of horizontal territory. But it does not seem reasonable that so broadly ex-

[1] Chem. and Geol. Essays, p. 248.
[2] Idem, p. 244.
[3] Geol. Trav. Handbook, p. 68 and note.
[4] Limest. Belts of West'r Co., Am. J. Sc., XX., 21 and following numbers, especially pp. 371 and 455.
[5] Annals Lyc. Nat. Hist., Vol. VIII., p. 108 seq.
[6] A large chart giving a detailed description of dips and strikes is deposited in the Library of the Academy. [Ed.]
[7] Am. Jour. Sci., XX., pp. 436 and 441.

tended and thin a stratum could by any possible convulsion be doubled up together so as to give these results. The synclinal mapped seems beyond dispute; as for dividing up the strata each side of it, I do not feel justified in doing it.

The topography of the upper island has been treated by Prof. Dana with great minuteness.[1] The level parts or low-lying parts are doubtless due, in large measure, as he suggests, to the former presence of limestone, which has been eroded away, and that the Harlem River owes its channel to the same cause. But the bend of the river to the east at McComb's Dam requires another explanation, and as its course corresponds very closely to the direction of the glacial scratches, it may have been directed thus by the glaciation. The subsequent course of the East River may be an ancient outlet of an eastern watershed, under different conditions, as suggested by Dr. Newberry.[2] From a local survey, I see nothing to contradict or corroborate. Prof. Dana has noted evidence tending to show that the Manhattanville depression is due to an "oblique wrenching and faulting of the rocks," and it is possible that the same movement may have caused the breaks at Inwood and Spuyten Duyvil. Prof. Dana ascribes to the mountain-making epoch at the close of the Lower Silurian the outlining of the island's important features. This may be true, and it likewise may be that the final contortions and foldings may have a connection with the great trap outburst across the river.

Minerals.—Lists of the minerals found on the island have been given in the New York State Report and in Cozzens' Geology. In the *Annals* of the Lyceum, Vol. VIII., there is a paper by S. C. H. Bailey that treats the subject very fully. It is not my intention to repeat anything said in those papers, but simply to record a few observations made while studying the geological formation.[3]

The minerals of the island fall naturally into four classes: 1. Those indigenous to the gneiss; 2. Those indigenous to the granyte; 3. Those indigenous to the limestone; 4. Those resulting from decomposition.

1. The gneiss contains masses of quartz, occasionally of some size, and of the smoky, ferruginous, and milky varieties. Crystals are rarely found.

The feldspar is of several varieties. Orthoclase occurs, flesh-colored, brick-red, and a light, semi-transparent brown. Oligo-

[1] Am. Jour. Sci., XX., p. 440–443.

[2] Pop. Sci. Monthly, XIII., p. 652.

[3] In number of species New York Island has been one of the most prolific localities in the world. The *Transactions* will soon contain a list complete to the present time.

clase is of the characteristic green, and often shows on massive pieces the twinning striations with great distinctness. The segregated masses carry other minerals. One in the accompanying collection has a very good crystal of tourmaline, calcite and pyrite with it.

Kyanite occurs over a limited area as stated above. The Villard houses, Madison avenue and 50th street, were the occasion of bringing much of it to the surface. It is in thin blades, and rarely shows a good blue. Prof. Dana has also found the allied mineral fibrolite in the region just north.

Garnets are abundantly distributed through the schist, but rarely of good crystalline form. They are then 202.

In the excavacations at 101st street and Fifth avenue, Mr. Slack and myself have found a mineral that we determine to be scapolite. It is white or yellowish-white, in large square prisms, but somewhat affected by decomposition. I do not think it has previously been recorded from the island.

Magnetite occurs in irregular masses of small size. What I have seen is in segregated bunches of quartz.

Pyrite is quite widely disseminated, but never in very great amounts. Dr. Gale attributes much of the disintegration of the gneiss to its decay, but I think he overrated its effect.

Malachite occurs as a green stain in the gneiss about 100th street and Madison avenue, but from 6 to 10 feet below the surface. It comes from the decomposition of chalcopyrite which is very sparsely disseminated through the gneiss.

2. *Granyte.*—The most interesting mineral from the granyte is tourmaline. It occurs in prisms, often of considerable size, everywhere in the upper island. It is very difficult to get out, however, as it is extremely brittle. Quite often crystals are seen broken across and the crack filled up by the matrix. This is a fact to be considered in any explanation of the origin of the granyte.

Mica occurs in broad leaves, often six inches and more across. Some in the Columbia College collection have dendritic stains between the laminæ. In some veins the mica is a very delicate and beautiful green.

Orthoclase occurs in large cleavage masses, and rarely in crystals.

3. *Limestone.*—Excellent, but somewhat weathered crystals of white pyroxene may be dug from the calcareous sand near Inwood, and with them are masses of fœtid quartz and feldspar.

4. The products of the decomposition of the gneiss have filled its cracks with secondary minerals. Stilbite is quite common in red radiated crystals, and its allied minerals, chabazite and heulandite, are said to have been found in ex-

cavating the Fourth avenue tunnel. Epidote is now and then seen on a fissure face, evidently the result of the decomposition of hornblende.

Artesian Wells. The only economic subject in connection with the rocks is the artesian well. Efforts have been made since the beginning of the century to obtain water from wells, both surface[1] and artesian. Dr. Elwyn Waller informs me that over a thousand exist at present. Within the last ten or fifteen years very many artesian wells have been sunk by the oil-well methods and the diamond drill. Many of the large breweries, malthouses, and manufactories demand an abundant supply of water and have found it advantageous to sink wells in preference to paying the city water-rate. Sometimes they are successful in striking a wet spot and a good supply is obtained; but, as there is no certainty from the nature of the formation, they quite as often yield very little. Still, the straitened capacity of the reservoirs and the small head allowed consumers have greatly quickened the well industry. They are drilled by the methods perfected in the petroleum districts and, indeed, one can hardly journey very far around the city, without seeing the tall derrick, and hearing the creak of the bull wheel and the thud of the drill. The wells are sunk by contract at from $6 to $12 per foot, the contractor fixing his price on his estimate of the hardness of the rock. Much difficulty is experienced on account of this varying hardness, as the drill tends to glance and make a crooked hole. Ordinarily the progress is 20 feet in 24 hours. The drillers say they are obliged to go down from 400 to 1,000 feet to strike water. The following facts have been obtained by inquiring of the drillers, and may not be very exact.

Schaefer's Brewery	640 ft.	5,000 bbls. daily.
63d St. Malt House	414 "	2,700 " "
Third Ave. and 67th St.	1250 "	10,000 gals. "
Sixth Ave. and 59th St.	730 "	10,000 " "
Field's Building, 1 Broadway	400 "	57,000 " "
Foot 58th St., Hudson River	700 "	Unsuccessful.
[2]Munic. Gas Co., 11th and 45th, 2 wells,	500 "	each, 30–45,000 gals. daily.
Tenth Ave. and 39th St.	468 "	40,000 " "
W. 41st St., No. 529	585 "	20,000 " "
Foot W. 39th St.	550 "	90,000 " "
Sterns, Third Ave. and 42d St.	600 "	8,000 " "
11th Ave. and 48th St.	600 "	30,000 " "

99th street and Second avenue, 7 wells, 38 feet each in drift, total of 216,000 gallons per day.

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[1] See a very quaint and amusing incident in Cozzens, p. 30, seq.

[2] The figures from here on have been kindly supplied by Dr. Elwyn Waller.

That the island is not of a formation to encourage well-drilling will appear from the chart and sections, inasmuch as it is narrow and the strata are not bedded at the proper angle to bring water from a distance. What is obtained must be surface water. And surface water from an area averaging 58,000 persons to the square mile, not to mention horses and other animals, could not be expected on *à priori* considerations to furnish wholesome water. That it actually does not has been shown by the analyses of Dr. Waller and other chemists.

Literature on the Subject.

"A Geological History of Manhattan or New York Island," by Issachar Cozzens, Jr. New York, 1843.

"Report on Fourth District, N. Y. State Survey, Geology of the Island," by Dr. Gale. Page 518.

Paper on the "Geology of Manhattan Island," by Prof. R. P. Stevens. Annals Lyc. Nat. History, Vol. VIII., p. 108. A list of unpublished papers is there given.

H. Credner: "On the Geology of the Vicinity of New York City." Zeitschrift der deutschen geologischen Gesellschaft, XVII., 1865, p. 390.

Paper on the same, by Prof. J. S. Newberry, Pop. Sci. Monthly, Vol. XIII., p. 652.

Mentioned in Prof. Dana's papers on the "Limestone Belts of Westchester Co." Am. Jour. Sci., Vols. XX., XXI., XXII.

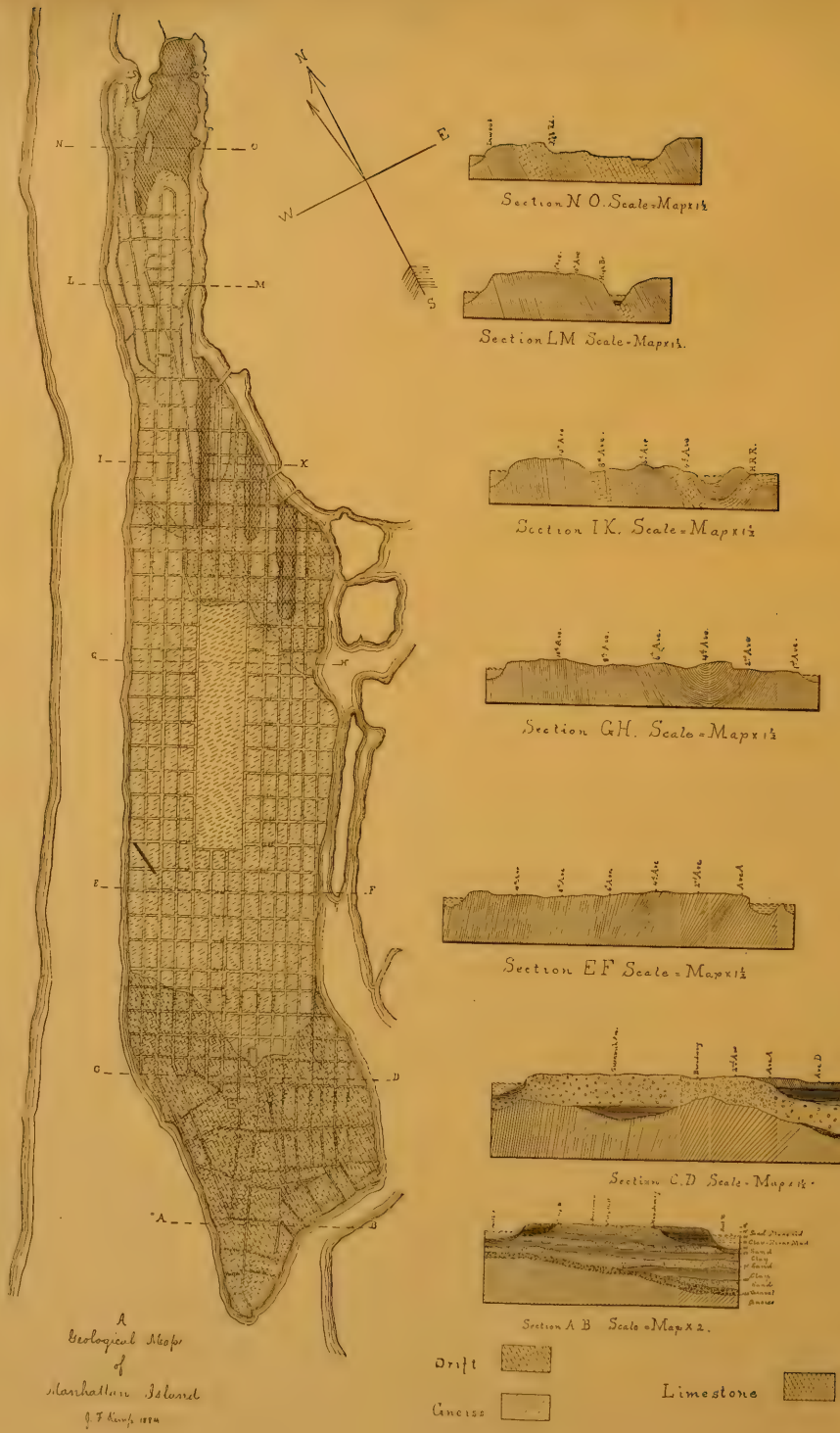
DISCUSSION.

PROF. W. E. TROWBRIDGE spoke of the desirability of a topographical and geological survey of New York Island before it should be entirely covered with buildings. Future questions relating to sanitary conditions, underground railways, etc., would depend upon facts which could only be determined and preserved by such survey.

PRESIDENT NEWBERRY briefly described the geological history of New York Island and vicinity. He regarded the chiefly vertical strata as rendering tunnelling difficult, and water from borings impure.

PROF. D. S. MARTIN spoke of the definite mineralogical character of the New York gneiss, of its continuation southeastward, and its evident distinctness from that of the "Highlands."

HON. CHARLES P. DALY referred to former features in the



A Geological Map of Manhattan Island

J. F. Kemp. 1884

topography of the lower part of the island. He also spoke of the desirability and certainty of some form of arcade underground railway to meet the demands of the great population of the future.

November 21, 1887.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Twenty-one persons present.

Garnets from New Haven, Conn., were exhibited by the President.

PROF. D. S. MARTIN exhibited Prof. Carvill Lewis' map showing the glaciation of Great Britain, which elicited remarks from DR. H. C. BOLTON and the PRESIDENT.

DR. H. C. BOLTON exhibited an original letter, dated April 30th, 1801, written by Dr. Edward Miller, of New York, to Dr. Elisha North, of Goshen, Conn., which contained information bearing upon *the early history of vaccination in New York City.* The circumstances under which the letter was written are as follows:

Dr. Elisha North practised vaccination in Goshen during the winter of 1800–01 with marked success. In the spring, a young man by the name of Ives went to consult Dr. North for divers slight ailments and a sore on his hand. This sore Dr. North recognized to be a cow-pox pustule, and, on inquiry, learned that it was produced directly from the udder of a cow while milking. With lymph from this pustule, Dr. North vaccinated an infant successfully, and from the infant vaccinated a Mr. Hunt. This latter going to New York on his private business while the lymph was fresh, went, at Dr. North's request, to call on Dr. Edward Miller, and the New York physician thus obtained fresh vaccine matter. The letter exhibited was one by Dr. Miller thanking Dr. North for his kindness in sending him vaccine matter.

The date of the introduction of vaccine matter into New York

City by Dr. Elisha North is March 25th, 1801 (*Medical Repository*, 1801), and is two months earlier than the date, May 22d, 1801, at which Dr. Valentine Seaman made his first trial of vaccination. Yet Dr. Seaman is often credited with being the first to practise vaccination in New York City. It is interesting to note that the lymph used by Dr. North was derived from an American source, and not imported from England as had always been the custom. Further details of these circumstances, with the entire letter, will be found in the Transactions of the Conn. Med. Society, Vol. III., p. 135, 1887.

Dr. O. P. Hubbard related some of his early experiences with small-pox, showing the efficiency of vaccination; and the President spoke of the great benefit of vaccination, and how, by its means, small-pox had been almost banished from civilized communities.

The President announced that the friends of the late Mrs. Erminnie A. Smith were making an effort to secure a fund, to be known as the "Erminnie A. Smith Memorial Prize Fund" at Vassar College.

President Newberry presented an informal paper upon

MARBLES; THEIR ORIGIN, DISTRIBUTION, AND QUALITY.

Prof. John C. Branner communicated[1] an informal paper entitled:

ADDITIONAL NOTES ON THE LANTERN-FLY OF BRAZIL.

In the September number (1885) of the *American Naturalist*, I published a short article upon the "Reputation of the Lantern-Fly," in which I called attention to the deadly qualities attributed to this insect by the Brazilians, and giving what evidence I was able to collect by personal observation and from trustworthy authorities regarding its true character.

The article was translated into the Portuguese language, and republished in Brazil. The *Liberal Mineiro* newspaper, published in Ouro Preto (formerly known as Villa Rica) also reprinted the article, and prefaced it with some remarks that I translate here as affording additional testimony in regard to this

[1] The communication was read by Prof. D. S. Martin.

insect, alike as to its reputation in Brazil, its harmless nature, and its light-producing powers.

The editor who makes these comments is Dr. Bernardo Pinto Monteiro, one of the leading citizens of the province.

(From the *Liberal Mineiro* newspaper, Ouro Preto, Province of Minas Geraes, Brazil, Dec. 19th, 1885.)

"*The Gitiranaboia* (Lantern-Fly).

"Everybody in Brazil knows the frightful stories told of the terrible *gitiranaboia* (lantern-fly). It is well known also that there are plenty of places in the interior of Minas Geraes where the people travel all the time with their umbrellas up for fear of being touched by this fatal insect—this species of winged death!

"The people, who are so fond of everything that smacks of the miraculous and mysterious, go on scattering these fables, which, by simple force of continual repetition, have come to be looked upon as the truth.

"It is not long since we had a kind of crusade in this country against the *eucalyptus* trees, because it was said that these trees were the chosen resort of this dreadful insect, which insect is, as a matter of fact, as innocent as the butterflies that hover about the flowers in our gardens.[1]

"Those whose business it is should seek other reasons, if there are any, for making this war upon trees that furnish good timber, and should leave the poor *gitiranaboia* (lantern-fly) in peace.

"For the most part, this creature owes its bad reputation to its ill-shaped figure, and to the beak it carries beneath its body, which, however, is as harmless as any briar.

"A good specimen of the insect known in the province of Minas Geraes as the *gitiranaboia* has been given me by Dr. Claudius Pereira da Fonseca. It is a true *Fulgora*, which, although it does not produce light, is called *lanternaria*. It is unquestionably the same that was nicely figured in 1788 in the dictionary of technical terms used in natural history, and taken from the works of Linneus by Domingos Vandelli, and it is also the same as the one figured and referred to by Dr. John C. Branner in his paper published in the *American Naturalist*. There is scarcely a single lover of curiosities in Ouro Preto who does not possess at least one specimen of this poor, much abused

[1] In 1882, Prof. C. V. Riley, U. S. Entomologist, showed me a clipping from a Spanish-American paper in which it was stated that these lantern-flies bred in large numbers upon the eucalyptus trees in Southern Brazil, and that they destroyed nearly all the cattle in that part of the country. —J. C. BRANNER.

insect. Specimens of it are constantly being caught about the windows and walls in this city, and thus far there has not been a single victim to its devastating fury."

Here follows the translation of the article upon the "Reputation of the Lantern-Fly" taken from the September number of the *American Naturalist* for 1885.

November 28, 1887.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the Chair.

Sixty-nine persons present.

MR. A. L. EWING exhibited a water inclusion in quartz, from Brazil.

DR. H. CARRINGTON BOLTON read a paper entitled

NOTES OF RECENT TRAVEL IN EUROPE.

(Abstract.)

Under this title Dr. Bolton spoke of his experiences and observations of a scientific and literary character during the preceding summer. After alluding to the deplorable condition of the stokers on ocean steamers, who work in a temperature varying from 92° to 98° (outside being 67°), the speaker pointed out the literary blunder on a tablet erected in 1882 in Westminster Abbey by the dean and chapter. It reads, to the memory of "J. Lemuel Chester, L. L. D., of Columbia College," instead of LL.D., as every tyro knows it should be. In Oxford he visited Dr. J. A. H. Murray, and the remarkable iron "scriptorium" in which the manuscript of the new English dictionary of the Philological Society is preserved. He also visited the Bodleian Library, and made some study of the portraits of Priestley in the Hope collection, and of Dr. Dee's alchemical manuscripts in the Ashmolean collection. He exhibited a photograph of the statue of Dr. Priestley erected in the University museum.

At Brighton he examined the workings of Volk's Electric Railway, a line first opened in August, 1883, and extended afterwards to one mile in length. Cars seating thirty passengers are run at a speed of eight miles an hour by an electric motor

of ten horse power placed beneath the floor. The electricity is generated by a fixed Crossley gas engine of twelve horse power, which drives a Siemens dynamo, the current from which is conducted to the rails by cables under the road. There are two steep gradients (1 in 28, and 1 in 14) but the line is generally level, running along the beach. The expense of operating, after four years' experience, is said to be far less than that of steam or horse power. Over one million of passengers have been transported without the slightest injury. A similarly constructed railway exists at Ryde, I. W.

Crossing the channel to Jersey, the speaker was struck chiefly by the tides, which rise forty feet, and by the cabbages, which grow on stalks eight to twelve feet high. He spoke of the decreasing population, of the picturesque rocky headlands on the north coast, of the geological features, and of the flora and fauna of the island. Passing to France, he proceeded through Brittany to Bordeaux. At Rennes he observed in the handsome park "*Le Thabor,*" near the Archepiscopal Palace, a long, wide, and deep excavation, called by the people "*l'Enfer;*" inquiry established the fact that the excavation had been made by priests of the adjoining monastery, condemned to do penance by digging the hole and throwing up the earth. The banks are now surmounted by large and old trees. A case of the earth being modified by man, and not a geological phenomenon.

At Bordeaux, he noticed on the occasion of the National Fête, July 14th, a great consumption, in the evening, of barium and strontium nitrates. On the railway between Bordeaux Dr. Bolton was mistaken by French officials for a German spy, and was closely interrogated by a gendarme, but on showing his passport was suffered to proceed.

He alluded to the resemblance between Vichy and Saratoga, to the new monument to Ampère at Lyons, of which he was a native (born January 22d, 1775), and to some enormous hailstones that fell one hot afternoon in Geneva. This storm was followed next day by an atmosphere so pure that Mt. Blanc was distinctly and uninterruptedly seen from before sunrise until after sunset. At Montreux he examined the works of the *chemin-de-fer funiculaire* ascending to Glion. The line, which has an inclination of 57°, is constructed with a central cogged rail, into which cogged wheels on each car are adjusted. Two cars are so connected by cable that when one is at the top of the incline the other is at the bottom, and the motive power is the weight of water introduced into a reservoir beneath the upper car; the water flows into the reservoir from a stream above; as soon as enough enters to overcome resistance, the car moves slowly downward, shutting off the water automatically,

and pulling up the other car with its load. At the bottom of the incline the water is automatically discharged from the reservoir. Railways are now run on this plan in several places in Switzerland. That in question is operated all the year around; the expense is obviously very small.

In the valley of St. Nicholas, on the road to Zermatt, the speaker noticed the method adopted by small farmers to recover meadow land from the ravages of the glacier torrent. By constructing low stone walls at right angles to the stream and extending a short distance from the banks towards the centre, silt is entrapped so rapidly that the space between the walls in course of time becomes completely filled; a coarse grass springs up, and the ground is redeemed. Specimens of the very fine silt collected by him have been placed in the hands of Dr. A. A. Julien for microscopical study.

At the Rhone glacier Dr. Bolton examined the artificial tunnel excavated in the ice and particularly observed the very beautiful color of the light within the tunnel; the tunnel being serpentine, all the light within passed through a thick roof of ice, and the color within was of a lavender blue, brilliant and trying to the eyes. At Luzerne, the speaker visited the so-called Gletscher-Garten, discovered in 1872–75, with its wonderful glacier mills, the largest measuring 8 m. in width and 9.5 m. in depth.

In Munich, Dr. Bolton had the pleasure of social converse with Professor Charles A. Joy, a former president of the Academy, and always its well wisher. Professor Joy sent messages of remembrance to all his friends in the Academy.

Dr. Bolton alluded to the singularly obstructive rules for obtaining books at the Royal Library, Munich, twenty-four hours' notice being required, and spoke of the superb library building at Stuttgart. In Frankfurt, the "Palmen-Garten" with its magnificent conservatory of palms was commended to botanists. A photograph of the interior of the conservatory was exhibited.

In Holland, the speaker made a visit to the little island of Marken; being in the Zuyder Zee, some miles from the mainland and accessible only by sailboats, the inhabitants have preserved, to a notable extent, ancient costumes and customs; they have intermarried to a very large extent, and the speaker thought the little girls especially looked strikingly similar, as if cousins.

In Brussels, the speaker noticed another electric railway run by a motor operated by accumulators placed beneath the seats.

Referring to London, he spoke of his personal friendship with the descendants of the celebrated divine and chemist Dr. Joseph Priestley, and exhibited a historic cane now in his possession, which was given to Priestley by Thomas Jefferson, third

President of the United States. The cane is a Malacca stick with a plain ebony top and a gold band. He also exhibited a number of letters written by Priestley to Wedgwood between 1780 and 1792, and promised on another occasion to make their contents public.

The PRESIDENT remarked upon certain topics mentioned in the paper.

December 5, 1887.

REGULAR BUSINESS MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Forty-three persons present.

The Report of the COUNCIL recommended as follows :

I. The election, as Resident Members, of

LIEUT. T. L. CASEY,
JOHN N. FARRAR, M.D.,
MR. GEORGE MCKIBBEN.

II. The change in Chap. III., Section I. of the By-laws of the words, *one hundred*, to *two hundred and fifty*.

III. The payment of certain bills.

The candidates were elected by formal ballot, and the bills ordered paid. The second recommendation was laid over one month, under the rule.

The Council also announced a contribution, by DR. H. CARRINGTON BOLTON, of $100 to the Publication Fund.

The members nominated for Fellowship, November 7th, 1887, were elected by formal ballot.

DR. HENRY A. MOTT read a paper on

THE VELOCITY OF GRAVITY.

The PRESIDENT and PROF. TROWBRIDGE made remarks upon the subject of the paper.

MR. GEORGE F. KUNZ announced, through the Secretary, two new undescribed iron meteorites ; one from Linville Mountain, Mitchell Co., N. C., weighing seventeen ounces ; another

from near Clear Creek, Wyoming Territory, weighing twenty-five and three-fourths pounds.

December 12, 1887.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Fifty-four persons present.

An invitation to the decennial anniversary of the Engineers' Club of Philadelphia, on December 17, 1887, was read; also an announcement from the Smithsonian Institution of the election as Secretary of Samuel P. Langley.

PROF. W. LECONTE STEVENS exhibited and described

NEW APPARATUS FOR DEMONSTRATING THE LAWS OF REFLECTION AND REFRACTION.

Various devices are in use for this purpose, the best known of which is the circular tank introduced by Tyndall, the lower half of which is filled with water rendered slightly cloudy in order to trace the path of the refracted ray in it, while in the upper half is smoky air through which the path of the incident ray is to be traced. The lantern beam is deflected obliquely downward by means of a mirror so as to enter the water at the centre of the circle. Because the surface of the refracting medium must remain level, a number of inconvenient adjustments are required whenever the angle of incidence is varied. The index of refraction of water being only 1.33, the deviation of the ray on entering it is not very striking, and the cloudiness of the water often constitutes an obstacle rather than an aid in demonstration, because the deflected beam becomes diffused at a very short distance below the surface.

In the present apparatus these difficulties are all avoided. The refracting medium is a hemicylinder of polished glass, mounted so as to turn on a horizontal axis. The radius is 2.5 cm., the length 5 cm. The axis passes through the centre of a circle of white cardboard whose radius may be 20 cm. or 30 cm. Each of its quadrants is graduated from 0° to 90°, as shown in the accompanying cuts, the diameter connecting the two zero points being perpendicular to the diameter of the hemicylinder of glass. A beam of light is sent through a horizontal slit in front

of the lantern, transmitted through the glass at the middle, and focussed upon the point A (Fig. 1), the plane surface of the hemicylinder being perpendicular to the beam. The incident,

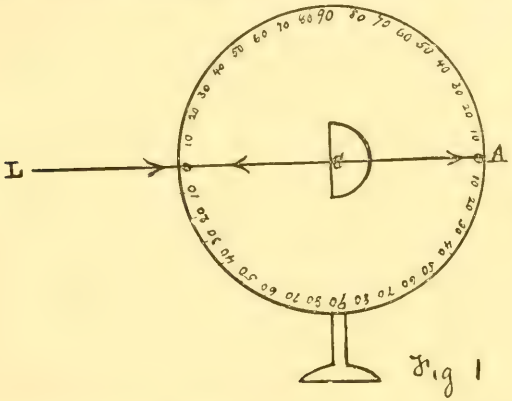


Fig 1

reflected, and transmitted beams are all in the same horizontal line. The cardboard being slightly turned toward the lantern, the path of the beam on it is easily seen with good definition. The room should be but half dark, so that the graduation can be

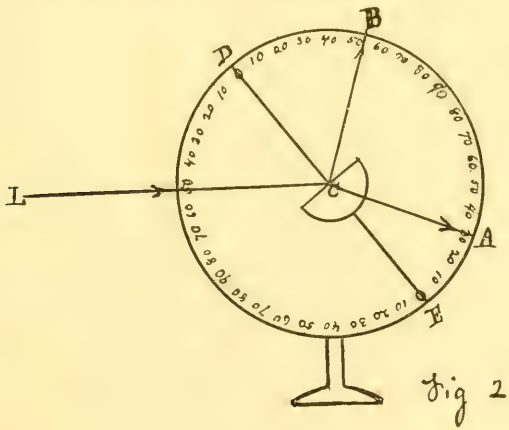


Fig 2

read on the circle. Turning the hemicylinder now through any desired angle, such as 50°, the cardboard moving with it, part of the beam is reflected and part refracted; both beams are

plainly seen, and the angles of reflection and refraction are measured. It is readily observed, moreover, that, as the angle of incidence increases from 0° to 90°, the ratio of the quantity of reflected light to refracted light increases. Turning still further,

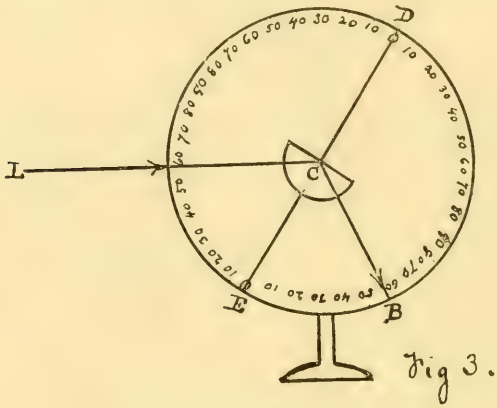


Fig 3.

the beam from the lantern strikes normally on the curved face and is totally reflected within the glass at its plane face. Turning now still further, the reappearance of a refracted beam announces the critical angle, which is read on the circle.

The special advantages of this very simple apparatus are as follows :

I. No new adjustments of the beam are required, however the angle of incidence may be varied.

II. The high index of refraction of glass causes more noticeable deviation than when water is used.

III. The beam of light, both before and after division, is better defined.

IV. The necessary expense is scarcely anything more than that of grinding the hemicylinder of glass.

In every particular this is more convenient than any other apparatus for the same purpose than the writer has seen.

For the suggestion of a hemicylinder the writer acknowledges his indebtedness to an old note-book belonging to his friend, Prof. D. G. Eaton, who did not have the apparatus made.

Prof. D. S. Martin spoke in commendation of the apparatus, as one of great simplicity and elegance.

Prof. W. P. Trowbridge and President Newberry presented observations on

THE MECHANISM OF FLIGHT IN SOARING BIRDS.

(Abstract.)

PROF. TROWBRIDGE first read from Sir Samuel Baker to illustrate the fact that birds, the condors and buzzards, for example, remain in the upper atmosphere for many hours at a time. This would indicate that, through some mechanism, such birds were largely relieved from muscular effort of the wings; as it is impossible for any muscle to remain for a great length of time under continuous strain. (See Transactions, vol. VI., page 118.)

The discovery by Prof. Jeffries Wyman (Proc. Boston Soc. of Nat. Hist., vol. V., p. 169) of the locking and stiffening of the wrist and elbow joints in extended wings, added an important element to the mechanism for relief of the muscles. The locking of the outer primary feathers, announced at the meeting, October 17th, was another element. A tendon or "tie" to support the extended and stiffened wing, and supplement the weak point at the shoulder, would make a complete mechanism. From a partial examination, Prof. Trowbridge thought that such a tendon existed.

He had found that many birds besides the soaring birds had the notched primaries.

With regard to *soaring ascent*, Prof. Trowbridge remarked as follows:

It has always excited wonder that a soaring bird can mount upwards in what appear to be circular evolutions without flapping its wings. Mechanically considered, such evolutions are possible only when there is a horizontal or upward vertical current of air. The ascent without flapping the wings, and a long-continued soaring flight, are impossible in stagnant air. Although almost self-evident, this proposition has not heretofore been clearly stated, as far as I am aware, in any discussion on the mechanics of flight, where birds mount upwards without flapping.

But in a current of air, parallel to the earth's surface, or obliquely or vertically upwards, such evolutions become possible. Suppose a bird with outstretched wings to be for a moment at rest with reference to the earth in a moving horizontal current; it is carried along by the wind, but not with the full rapidity of the air-current; its course, due to the action of gravity and the wind combined, being slightly downward. It soon acquires a momentum and kinetic energy due to these forces acting jointly, but mainly due to the velocity of the wind.

A slight movement of the tail or of the wings without flap-

ping will cause its direction to be changed, first across the wind, and then upwards and against the current; and the living force that has been acquired, will carry it to a plane higher than that from which it started, and, for some distance against the wind, but never as far backwards as the point of starting. A second evolution like the first carries it still higher, and so on, the bird rising in a helical path like the windings of a stairway, but always falling off or making leeway with the direction of the wind.

The bird may thus rise to any height. At great altitudes, if the currents of air are nearly or quite vertically upwards, the successive helices may be nearly over each other and nearly in the same horizontal plane, and the bird may apparently soar "in circles."

If we now consider that the bird, in soaring under these circumstances, is quite relieved from muscular exertion, excepting the very slight efforts necessary for changing direction, and that these exertions may be accomplished involuntarily or unconsciously, the popular idea that some soaring birds sleep on the wing is not to be lightly denied. We all know that men sometimes sleep while performing work which is usually done by voluntary action and in a state of consciousness, the voluntary muscles becoming for a time involuntary muscles and their efforts being unconsciously performed. Many ordinary movements during sleep are thus effected unconsciously by all animals.

The discovery of the methods by which the most severely strained of all the muscles of the wing may be relieved from constant exertion,[1] both in soaring and in other long-continued flights during migrations, may thus enable us to solve what has hitherto been regarded as one of the most puzzling of all the mechanical problems of flight.

PRESIDENT NEWBERRY discussed the subject of soaring, and read extracts from Prof. Jeffries Wyman referring to the locking and "setting" of the joints of the wing.

He said that, in considering the anatomy of birds' wings and the function of flight, there were three elements under discussion, apart from the flapping of the wings. These were: 1, soaring by gyration, credit being due Prof. Trowbridge for the only satisfactory theory; 2, "setting" of the wings by locking of the joints, credit for this discovery being due to Prof.

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[1] This refers to interlocking of primaries, see page 19, and locking of wing bones, see page 75.—ED.

Wyman; and 3, interlocking of the primaries, as claimed by Prof. Trowbridge.

Abstract of the Discussion.

Mr. Chittenden thought that no single or uniform law would be found to cover all the problems involved in the flights of different birds.

Mr. D. G. Elliot spoke in opposition to the interlocking of the primary feathers. He claimed that if the imbrication of the vanes of the primaries were ever reversed, it is by accident, and that it would be a source of weakness; that there were no muscles or provision for moving or rotating the quills so as to produce the interlocking at will; and that the notching or emargination was lacking in some soaring birds, and present in many families which did not soar; and also that the notched primaries were apart in the buzzard when soaring; and that to an ornithologist the theory was absurd.

Prof. Trowbridge, in reply, stated that he had found in a recently killed bird a tendon which opened or spread the outer primaries, and had observed such a rotation of the extremity of the wing at the wrist as caused the primaries to assume an oblique position, and to drop naturally into the locked state under certain conditions.

Mr. Elliot thought the extension and rigidity of the wings of birds after death was *rigor mortis*.

President Newberry said that the occurrence of the rigidity of birds' wings after being killed must be accepted as a fact. That it was not consonant with physiological laws to have only one set of muscles rigid in *rigor mortis*, and the rigidity was more likely a matter of will. That in shooting large game it always happened that the animal fell in a heap. The legs did not stiffen and keep the creature standing.

Prof. J. A. Allen thought that a mistake had been made in regard to the interlocking of the primaries. The inversion of the primaries would defeat the purpose of the peculiar construction of the feathers and wing. He believed that the position of

the primaries in the hawk killed by Prof. Trowbridge's son was probably a result of accident. The power of sustained flight was due to the remarkable development of the pectoral muscles and the lightness of the animal.

In reply to an inquiry, Prof. Allen said that the emargination of the primaries seemed more pronounced in birds of swift flight, but was wanting in some birds of soaring character. It was, perhaps, a sexual characteristic in some groups, as only the males in some species possess it.

MR. GEORGE B. SENNETT exhibited the wing of a frigate bird, showing that, in this bird, the "soarer of soarers," the emargination of the primaries was entirely lacking. The whole structure of the bird's wing was to secure lightness, elasticity, and stiffness; and fixedness in the position of the feathers was a necessity. There was no movement of the quills to produce interlocking, which was a novel, but untenable theory.

DR. H. C. BOLTON announced the formation of a Folk-lore society, and the publication of a journal devoted to that subject.

December 19, 1887.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Fifty-one persons present.

PROF. O. P. HUBBARD exhibited a cast, one-half natural size, of a hailstone which fell at Fond-du-lac, Lake Superior, July 17th, 1869.

THE PRESIDENT exhibited samples of work by a new photo-graving process; also, in behalf of Mr. A. R. Ledoux, a new meteorite from Tennessee.

PRESIDENT NEWBERRY read a memorial of

J. Carson Brevoort.

It becomes my painful duty to announce to the Academy the death, on December 7th, of one of its oldest and most honored

members, Mr. J. Carson Brevoort, who resided at No. 36 Brevoort place, Brooklyn.

He was the son of Henry Brevoort, an intimate friend of Washington Irving, and was born in this city July 10th, 1818. After a thorough preliminary education in this country, he spent several years in study in France and Switzerland, graduating after a three years' course at the Ecole Central des Arts et Metiers, Paris, with the diploma of civil engineer. On his return to the United States, he assisted his uncle, James Renwick, one of the commissioners appointed for that purpose, in running the line of our northwestern boundary. In 1838, he was appointed private secretary to Washington Irving, who became United States Consul to Spain. He remained five years abroad at this time, in Spain, England, France, and Germany, returning to America in 1843. In 1845, he married a daughter of Judge Lefferts, of Brooklyn, and from that time onward continued to reside in that city, where he became well known and was highly honored. He long served on the Board of Education and the Board of Water Commissioners, and, in 1863, he was elected President of the Long Island Historical Society, an office he held for ten years. In 1852, he was appointed a trustee of the Astor Library, and for two years was superintendent of that institution. In 1861, he was made a Regent of the University of the State of New York. He became a member of the Lyceum of Natural History in 1840, and is believed to have been, at the time of his death, the oldest living member of the Academy; he was also a Patron of this Society, and an occasional contributor to the Annals. In natural history, his specialty was ichthyology, of which he had a good knowledge and the finest library in this country. His knowledge and interests were, however, far-reaching, and he contributed to the *American Journal of Numismatics* a series of papers on "Early Spanish and Portuguese Coinage in America;" to the *Historical Magazine* a paper on the "Discovery of the Remains of Columbus;" and he read a paper in 1871 before the American Geographical Society "On Giovanni de Verrazano and on a Planisphere of 1529, Illustrating his American Voyage in 1524." This was subsequently ex-

panded, and made into a volume, privately printed, and entitled "Verrazano, the Navigator."

Mr. Brevoort was always a great lover and collector of books, and his library in 1875 numbered over ten thousand volumes, many of which were very rare and expensive. He also possessed a valuable collection of medals and manuscripts.

Among scientific men, he held a recognized and honorable place, but his usefulness is in no degree measured by his literary and scientific remains. He was a man of warm heart and generous sympathies, and his books, his purse, and his counsel were always at the service of scientific workers; while his public spirit and philanthropy made him loved and honored as a citizen. Mr. Brevoort inherited a large landed property which, for a time, proved a heavy care and burden, but it ultimately brought the fruition of his plans in ease and even wealth. His home, at the corner of Atlantic and Bedford avenues, was one of the finest private residences in Brooklyn. There he lived for the last ten years of his life in the enjoyment of every luxury, which he shared with generous hospitality. A large part of his splendid library has become the property of the American Museum of Natural History.

The card announced a continuation of the

DISCUSSION ON THE MECHANICS OF BIRD FLIGHT.

PROF. W. P. TROWBRIDGE exhibited wings of hawks, prepared to show the tendons for the spreading, closing, and rotation of the primary feathers.

He reviewed the former discussion and the objections which had been offered to his theory, and said that he had studied the subject and treated it from the standpoint of a student of mechanics. He proposed to show a tendon which spread the primaries, a muscle in the palm of the hand which closed the same, and another which rotated the hand at the wrist; also the worn notches in the vanes. The existence of these tendons and their muscles having been disputed, he claimed the discovery by his own dissection.

By drawings upon the blackboard the relations of the parts of the wing were illustrated, and by wings of the red-tailed and

red-shouldered hawks, having the integuments removed, the offices of several tendons were exhibited. One of these, he thought, seemed to act as a "stay" or "tie" to support the stiffened wing; another connected the two ends of the curved ulna like the "tie-rod" of a girder.

He also read a list of soaring birds, chiefly hawks, which have emarginated primaries.

Prof. J. A. Allen said the tendon regarded as a support or tie was the patagium, which gives a straight line to the front border of the wing. The structure and anatomy of birds' wings were so well known that he thought it impossible that any muscles and tendons should have remained undiscovered by the anatomists. He thought the emargination of the primaries had little relation to soaring, as some birds remarkable for soaring flight were destitute of the feature, while many birds which did not soar possessed it. Some grouse had the primaries very much cut away. In some pigeons and some humming-birds the emargination was very pronounced. In some of the fly-catchers only the males possessed the feature. In genera, where the females lacked the emargination, the young males also lacked it.

Mr. D. G. Elliot denied the possibility of the rotation of the primaries, while admitting the motions of spreading and closing. The muscles producing the former movements, he thought, were involuntary, being a part of the abduction or stretching of the wing. He thought the notches in the primaries, which were rather characteristic of the raptores, although variable within the same genera, had no connection with the soaring.

Prof. Trowbridge said that he did not claim any rotation of the primaries individually, or apart from the rotation of the manus.

Mr. George B. Sennett regarded the interlocking of the primaries as entirely a mistake.

Mr. Ernest E. Thompson, of Toronto, Canada, being invited to speak, said that, as an ornithologist, he had given much attention to soaring flight, and had spent much time on the Western plains watching, with a glass, the buzzards and hawks soaring,

and had never seen any indication of inverted primaries. He thought that the reversion of the imbrication could not possibly have escaped the notice of ornithologists if it were common in any class of birds. He had recently experimented on pigeons with primaries interlocked, and found that it rendered their flight impossible.

PROF. TROWBRIDGE claimed that the experiments with pigeons were not a fair test, as the pigeon was not a soaring bird. He also claimed that the feathers could lock by a simple natural motion of the wing; that it was a natural position of the primaries, and that it was not a fair term to call it an "inversion of the wing."

PROF. ALLEN thought the wings shown by Prof. Trowbridge were so denuded and softened as to show too free movement of the parts, and an unnatural rotation.

He had been unable, by dissection and experiment, to find any natural movement or rotation of the wing or primaries which could cause the latter to overlap in the reverse order or to interlock. He produced a freshly-killed hawk, and MR. SENNETT asked PROF. TROWBRIDGE to make the primaries interlock by any motion of the wing.

A spirited colloquy ensued. The ornithologists present claimed that PROF. TROWBRIDGE had not demonstrated the interlocking of the primaries.

DR. N. L. BRITTON referred to the momentary flight of birds, back downward, as he had observed in the evolutions of an aërial fight between a fish-hawk and turkey-buzzard.

The PRESIDENT said the ornithologists should have charity for those who were not specialists in their line. The claim by Prof. Trowbridge that birds had the power to interlock their primaries must be settled by observation, not by assertion or ridicule. Being proposed by a student of animal mechanics, it deserved fair consideration. Instantaneous photography might, perhaps, settle the question. The President said further that modern improvements in the arts had been simply copying from Nature. That the discovery of great inventions, for example the telegraph,

telephone, and telescope, had been the result of groping after Nature's method. We had now come to the problem of aërial navigation, which was successfully accomplished by birds. It was the opinion of many that if man ever succeeded in this method of locomotion, it would be not by the balloon, but by some mechanical device in imitation of the flight of birds.

Dr. J. B. Holder read the following notes on the

SOARING OF BIRDS.

It is a matter of record that several notable scientific explorers, especially those who examined the fauna of South America during the first half of the present century, were attracted to the extraordinary evolutions and great apparent buoyancy of the large soaring birds of the region. But, for a long time, so far as we have been able to determine, attempts to explain clearly the phenomena of soaring, in its several phases, have been abandoned. Of late, considerable attention has been given to the theme, and several observers have approached what seems to be the true theory.

It is our purpose here to place on record some interesting data which will help the solution of this problem.

During the winter of 1858, while serving as medical officer at Fort Jefferson, Tortugas, on the Florida Reef, and when garrison duties allowed abundant time for observing the novel and interesting objects of that semi-tropical region, one of the first attractive circumstances was the apparently constant sojourn of the frigate pelican (*Tachypetes aquila*)—called there the "man-o'-war bird"—or "hawk."

There were many of these birds, and during the winter months they hovered over the fortress during the day, and roosted at night on the dwarf cedars of the neighboring keys.

Their wonderful poise and admirable faculty of soaring soon became a theme for continued observation, particularly as a lighthouse tower within the fortress afforded extended opportunities for view.

With a position in the lantern of the tower, and a good field glass, one was both concealed and brought into proximity to the birds, wholly satisfactory for purposes of observation.

Some mention of the soaring of birds by Humboldt, who observed the flight of the condor in its beautiful evolutions, and similar notices by Charles Darwin in his "Voyage of the Beagle," suggested a careful series of observations, and close scrutiny of this, the most notable flyer, in its chosen home.

During the prevalence of any considerable wind, the frigate bird was invariably soaring over the fortress, and, rather singularly as we thought, over the light-tower quite accurately and regularly, which afforded exceedingly favorable views.

A singular fact is that at night, either in moonlight, or when the sky is overcast, these birds are seen in their accustomed position.

It is a well-known circumstance of this region that a gentle breeze prevails during most of the time in the winter months, always from the east. This condition is pretty regularly interrupted, once in fourteen days, more or less, by a "norther," so-called.

The garrison ensign in this isolated post came to be a sort of oracle from which satisfactory instruction was frequently drawn. It could be depended on to indicate an impending "norther" by coming to a stand a few hours in advance, the mercury then indicating 80 degrees.

I do not recall an instance of the flight of a frigate bird at such times, excepting an occasional dash at plunder.

The birds were then quietly roosting. This dead level of quiet prevails but a few hours, and is anon rudely interrupted; the ensign veers quickly, and indicates a wholesale breeze; the north wind is instantly in force, and the frigate birds are almost simultaneously at hand directly over the light-tower. In the one feature, the heading of the birds to windward, lies the index to the solution of the problem involved in the soaring of birds. A remarkable circumstance is the perfect repose of the birds, blow it ever so rudely. The heaviest gales have no effect to lessen the perfect balance of the bird upon the elements; it rests as upon a pivot; scarcely leaving the field of the glass; swaying at times but never rudely, and never pushed aside in any direction.

This *quasi* condition of rest rendered observation, aided by the nearness afforded by the tower and glass, nearly perfect.

It had been claimed, in absence of a satisfactory explanation of the extraordinary buoyancy of such birds, that there must be *some* movement of the inner coverts which was not noticed at the altitude usually met with by the observer; and on such weak and unphilosophical subterfuge the subject has been dropped for many years.

There could be nothing added to our opportunity for exact observation; the rather low position of the birds usually, when soaring, and the nearness attained, unseen by them, were all that could be called for, and there is no denying the fact that these birds rest on the wind, their wings extended to the utmost, and the entire mechanism in a state of seeming catalepsy.

The body and wings are necessarily as one piece, as much so practically as the component parts of a kite, with no perceptible movement of one part upon another. These are facts; but it is a noticeable circumstance that those who have, in earlier times, considered the subject have not taken into account the inexorable requisite, the aim of the bird to windward.

We have in the case of the frigate bird, which is regarded as a typical soarer, a bird exhibiting the maximum of wing-spread, and a minimum of bulk. The centre of gravity is well forward in a small compact body; the head and neck are nearly buried in the feathers of the thoracic region; the feet and legs extremely small, and the tail reduced to insignificance, and forked. We have here the elements for a soarer, from which the typical toy kite may well have derived its principles.

Every boy who is ingenious enough to make a kite knows how requisite it is to construct the frame carefully, and more than all to adjust the rigging, so that the several forces which the completed toy is to meet in the air will have been harmonized to a nicety. The beautiful poise and nearly absolute state of quiet seen in a good kite are the result of considerable attention to details. What more natural than to compare the bird to a kite?

But, say the mathematicians, the familiar law of mechanics forestalls that. We claim that the intelligence of the bird unconsciously modifies the action of the forces in play—the wind and gravity—and produces equilibrium. Give the kite that intelligence, and cut the string. The simile is rational. We have a thin outline presented by the wings and body to the wind. So long as that outline is preserved, and the bird has the power to meet the requirements, it will adjust itself by tilting, allowing gravity to oppose the wind. The result is, as we see, a state of comparative rest.

We often see a piece of paper, as mooth stiff sheet, sail off with the wind, and, occasionally, see it rest for an instant between the two forces, the wind and gravity.

Of course, one force prevails eventually, but there is a point reached at times which exhibits the sheet of paper in an attitude very suggestive of the bird and the kite in their condition of soaring, but having neither string nor intelligence, it falls.

During the year 1858, I wrote an account of these observations, which was subsequently placed on record by Dr. William Stimpson, secretary of the Chicago Academy of Sciences.

I submitted them also to several officers of the United States Engineer Corps. The latter met the statements with the reply that a familiar law of mechanics militated against them.

I was gratified, however, by receiving from one of the officers,

Colonel Walter McFarland, a second letter, in which he said that, upon reflection, he must admit the theory as correct.

It chanced that his charge as engineer officer at Tortugas had given him similar opportunities for observing the frigate birds.

Mr. Darwin, in his pleasant account of the "Voyage of the Beagle," says of the condor: "Except when rising from the ground, I do not recollect ever having seen one of these birds flap its wings. Near Lima I watched some for nearly half an hour, without once taking off my eyes. They moved in large curves, sweeping in circles, descending and ascending, without giving a single flap.

"As they glided close over my head, I intently watched from an oblique position the outlines of the separate and great terminals of each wing; and these separate feathers, if there had been the least vibratory movement, would have appeared as if blended together; but they were seen distinctly against the clear sky.

"The head and neck were moved frequently, and apparently with force; and the extended wings seemed to form the fulcrum on which the movement of the neck, body, and tail acted."

I wrote to Mr. Darwin, detailing the particulars of my observations. In reply I received a letter in which he says:

"The same thought about the soaring of the condor formerly passed through my mind, but on consulting with mathematicians I am assured that it will not hold good."

Doubtless, had he subsequently turned the matter over in his mind, he would have come to the present theory.

The result of my observations was published in *Harper's Monthly* of that period, and also in the *Sportsman*, which was afterwards merged in the *Forest and Stream*.

On coming to New York in 1869, I submitted the same to President Barnard, of Columbia College, who claimed the supremacy of the law of mechanics as before applied. He did, however, think that, with very delicate instruments, which possibly some one might hereafter invent, the true explanation would be forthcoming.

The Duke of Argyll has, among many truisms, and after quoting some hitherto appropriate lines from Solomon, "'The way of an eagle in the air,' he knew it not," reached nearly the correct conclusion, as have several other late writers.

There are many interesting phases of bird flight which I believe may be better understood by using intelligently the simile of a sailing ship—the "sailing in the eye of the wind," "tacking," "jibing," "coming in stays," etc., but particularly

the matter of tacking. There would seem to be suggestions here of value.

Regarding the theory brought forward by Prof. Trowbridge, which involves the supposition that certain muscles are attached to the primary feathers, or in some way to the *manus*, or its phalanges, that produce certain movements of rotation, it would seem plainly a matter of well-known anatomical structure, and therefore one to be instantly decided by reference to the parts in question.

The primaries, like all other feathers, being dermal in origin and growth, as are homologous structures of the mammalia, namely, the claws, nails, horns, etc., have no use for muscular attachments. All such dermal organs alike are inserted in duplications of the skin from which they grow; the follicles furnished to each secreting the substance from which the feather is developed in one case, the nail in another, and scales and other peculiar dermal appendages in others.

Movements which affect the primary quills are the result of power applied to the bones on which the quills are situated. The distal ends of the tendons are inserted in the manus. There is no movement in birds' wings like those in the hand of mammals, the two principal ones are adduction, drawing the wing upon itself, and abduction, spreading its parts.

There is an automatic movement in the dermis of birds and mammals, which causes the familiar condition of "goose flesh;" and this shrinking of the skin is the cause of the erection of feathers as seen in fowls at times. The wrinkling of the skin on the back of animals is due to the same cause, both the voluntary and involuntary exercise of the unstriped muscular tissue, so-called, being the motors.

President Newberry remarked that the discussion included three quite distinct questions, which had been somewhat confused :—the problem of soaring flight, ascent by gyrating, and the interlocking of the primaries, which were to be determined by observation and experiment.

Prof. Trowbridge, in closing the debate, claimed that he had demonstrated the existence of a tendon to open or expand the primaries, the discovery of a muscle in the manus to close the same, and a rotary motion as the function of a special muscle which locked them.

It was voted to adjourn to January 9th, 1888.

January 9, 1888.

REGULAR BUSINESS MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Fifty-five persons present.

The Report of the COUNCIL recommended as follows :

I. The payment of certain bills.

II. The acceptance of the resignation of A. B. Judson and Cornelius R. Agnew.

III. To change Thomas B. Gunning and J. Ward Smith from Resident to Corresponding members.

IV. The election as Resident Members of

JONATHAN DWIGHT, JR.,
ALBERT R. LEDOUX,
GEORGE B. SENNETT.

The recommendations were severally adopted and the candidates elected by formal ballot.

It was moved by the SECRETARY, and voted, that action upon the proposed amendment to the by-laws offered December 5th, 1887, be deferred one month.

The Secretary submitted resolutions proposing changes in the by-laws, as follows :[1]

I. That the following changes be made in chapter III.

1. To insert after the word "Patron" in the title, the words :

And Life Members.

2. To append to Section 2, as it now reads, the words :

And shall be entitled to one copy of all the scientific publications of the Academy, appearing subsequent to the date of their contribution.

3. To insert, as section 3, the following :

Any Resident Member may become a Life Member by contributing at one time one hundred dollars toward the fund for the general purposes of the Society, and shall thereafter be exempt from annual dues.

[1] These changes were voted February 6th, 1888.

II. That in place of Chapter VII., as now existing, the following be substituted :

Of Sections.

1. Sections of special branches of science may be established or abolished by the Academy, upon recommendation of the Council, and one month's notice.

2. Sections shall be organized with at least a Chairman and Secretary, and these officers may take charge of the meeting of their section during the presentation of its scientific business.

III. That Section 2, of Chapter VIII. be amended as follows : To insert after the word "Patron" the words :

Or a Life Member.

Mr. George F. Kunz exhibited a specimen of the gold-bearing zinc blende from Wales.

Dr. N. L. Britton announced the discovery of an Archæan plant in the limestone of Sussex Co., N. J. Specimens were exhibited showing carbonized stipes, of a breadth from one-eighth to one-quarter of an inch, linear and parallel, and apparently algæ. He named this *Archæophyton Newberryanum.* A full description will be published in the Annals, Vol. IV.

Prof. J. A. Allen read a paper

ON THE STRUCTURE OF BIRDS IN RELATION TO FLIGHT, WITH SPECIAL REFERENCE TO RECENT ALLEGED DISCOVERIES IN THE MECHANISM OF THE WING.

(Abstract.)

After reviewing the discussions of December 12th and 19th, from the ornithologist's standpoint, and making some explanations of a personal character, the author read as follows :

It has been said that the problem of the flight of birds (and by implication the particular point under discussion) was a question of mechanics, and not of ornithology or anatomy. On the contrary, it is strictly an anatomical one, and wholly within the domain of ornithology. The general subject of the flight of birds is both mechanical and ornithological, since it involves the consideration of the structure of a bird's wing—its bony framework, its muscles, and its general form, which latter varies endlessly in different groups of birds.

Before proceeding to a detailed examination of the apparatus of flight in birds, one or two other points may be conveniently considered here. In the opening remarks of the first evening's discussion much was said on the general subject of flight, which was well said; yet statements were made respecting the ornithological aspect of the case which showed the speakers to be on unfamiliar ground. In speaking of the stroke of the wing in an upward direction as being restricted within narrow limits, it was said that birds are unable to strike their wings together back to back. In point of fact, the movement of a bird's wing at the shoulder is nearly as free as that of a man's arm, and we need only visit the farmyard to see domestic fowls and pigeons strike the backs of their wings together. Pigeons often do this with great force.

The continued sailing of a turkey buzzard shot dead in the air, till it reached the ground at a considerable distance from the point where it was killed, with its wings still extended, was referred to (as it had already been before the National Academy of Sciences, and twice in *Science*) as a rare phenomenon, and also as one readily explained by the new discovery. Instead of being rare, it may be said to be an almost every-day occurrence with sportsmen who do most of their shooting on the wing. It certainly would not be too high to place the average as at least one per cent of birds killed in the air. Neither is it confined to soaring birds, nor to birds shot while flying. It has happened many times in my own experience in birds shot out of a tree, the bird when struck starting to fly and expiring in the air, continuing its flight with the wings extended, but immovable, till it reached the ground by a very gradual descent dead and with the wings still extended. The list of instances would include birds of all sizes and groups and manner of flight, from sparrows, warblers, thrushes, titmice and swallows, up to game-birds, sea-fowl and birds of prey. How frequent is the remark of one sportsman or bird-collector to another: "There, you've hit him hard; watch him; he has set his wings and is coming down; mark him and you'll get him." The bird is marked down, falling, it may be, hundreds of yards away, and is found dead with its wings still extended.[1]

The soaring of birds has been referred to as an unsolved prob-

[1] Since this was written, the incident of the buzzard has again been alluded to in *Science*, this time by Dr. Coues, an ornithologist of unquestionable authority. Dr. Coues declares it has no bearing on the question, such phenomena being the result of rigidity due to nervous shock. This is exactly what Mr. Elliot said before this Academy in reply to the statement in question. And it is, furthermore, a perfectly evident explanation of all such cases.

lem. I fail to see, however, why the soaring of a toy kite does not furnish a key to the problem, a view of the matter now quite generally entertained. If we compare the soaring bird to a flying kite, and let the weight of the bird be represented by the string which holds the kite at anchor, and let the expanded wings and tail represent the body of the kite, and add the sensitiveness and intelligence of the bird as a steering power, have we not all the elements of the problem? The bird instantly perceives the necessity for any change of direction to maintain its position, and adjusts itself to the requirement by a slight movement of the tail or a slight inclination of the wings. I am perfectly familiar with a large part of the abundant literature on the subject; but it is foreign to my purpose to discuss the matter in the present connection, as it has been very well presented in the paper read by Dr. Holder at the meeting of Dec. 19th.

Passing now to the mechanism of a bird in its relation to flight, it may not be amiss to recall the fact that a bird is preeminently a flying vertebrate, and that every function and every organ, in short, the whole plan of organization, has reference to aërial life. The general form of a bird is that of two cones placed base to base, the neck and head forming the apex of one and the tail the apex of the other. It is clothed with a covering of elastic feathers, which are imbricated backward, and conceal all angularities of the body, presenting at all points a smooth and rounded exterior. The feathers are of the lightest texture, their shafts largely filled with air, as are likewise all the interstices between the downy filaments. The bones are for the most part hollow, and air-sacs are distributed throughout the body. The mode of reproduction is non-gestatory, and the bird is thus never impeded by the weight of its offspring. The principal muscles, those of flight, and the intestines, are on the lower side of the body, and so massed as to give a low centre of gravity. The bones that enter into the shoulder-girdle or scapular arch are all strongly bound together, giving firm support to the fore limbs, which are especially modified into organs of flight and adapted to no other purpose. The wings are attached to the highest part of the body, leaving nearly its whole weight below the axis of support, this giving the greatest possible force to the wing-stroke.

Of the bones, the sternum, with its great length, its broad lateral expansion, and its strongly developed keel, forms primarily the basis of the mechanism of flight, giving not only a large surface for the attachment of the immense muscles which move the wings, but one to which all the other bones concerned in flight are firmly bound. In front are the large coracoids, which run from the front edge of the sternum to the shoulder joint, into which they enter as important elements, besides affording

further surface for the attachment of the pectoral muscles. They are very broad at the sternal end, where they have the character of a strongly buttressed pillar, preventing lateral motion of the shoulder. The clavicles, attached distally to the shoulders, unite in front, forming an arch, which is bound by ligaments to the keel of the sternum, thus bracing the shoulders laterally, and preventing them from approaching each other. The long thin scapula, running upward and backward from the shoulder joint, and firmly bound to the thorax by strong muscles, gives stability to the shoulder in an upward direction. The shoulder joint itself is formed by the junction of the scapulæ, coracoids, and clavicles, where they are either anchylosed or bound firmly together by ligaments, giving a firm support for the head of the humerus, from which the motion of the wing proceeds. The humerus, as already said, has great freedom of movement at the shoulder; distally, at the elbow joint, it meets the two bones of the forearm, with which it articulates by a hinge joint, admitting of motion in but one direction, namely, in the plane of the extended wing. Any rotation is prevented by the character of the joint itself, and a special set of short muscles in addition to the ligaments usually present to give firmness to the joint.

The bones of the forearm have no rotatory motion whatever, but an antero-posterior movement upon themselves, alluded to during the evening of December 12th, as a brilliant but long-overlooked discovery of the late Professor Wyman. I then felt called upon to state that it was a contrivance so well known as to be specially dwelt upon in ornithological text-books as one of the most distinctive and striking features of a bird's wing, and as such familiar to every well-informed ornithologist. As Dr. Coues has since shown in a recent letter in *Science*, it was discovered nearly twenty years before it was made known by Wyman, and has had, during the last fifty years, no less than four independent discoverers. This mechanism is so important, interesting, and beautiful, that I have brought here a preparation which shows it, and which I shall exhibit later.

At the wrist-joint, motion is possible only in the direction of the plane of the expanded wing, the hand being incapable of rotating at the wrist, the joint being strictly a hinge joint. Two small bones compose the carpus, which participate in and render possible the sliding movement of the bones of the forearm. The hand consists of a compound metacarpal bone, which is really made up of three anchylosed metacarpals, to which are attached three digits, corresponding to digits ii., iii., and iv., of the human hand, the first and fifth digits being absent in birds. The first digit in birds is usually called thumb, though really homologous with the index finger. It has two

phalanges, is situated near the carpus, is easily flexible laterally as well as in the plane of the wing, and forms what is known as the alula or bastard wing. It covers the base of the outer primaries and has no important function. The second digit, corresponding to the middle finger in man, consists of two phalanges, and forms, by its size and length, the main bone of the digital portion of the hand. The third, corresponding to the ring finger in man, consists of a slight spur of bone seated on the inner edge of the metacarpal bone. The pinion, or manus, which is the part of the wing to which the primaries are attached, thus consists of three segments: first, the metacarpals, forming rather more than one-half its length; second, the first phalange of digit iii.; third, the second phalange of digit iii., this latter forming the tip of wing. Practically, then, the pinion is made up of two slender partly anchylosed metacarpal bones lying side by side, and surmounted by one long finger composed of two segments. This gives two joints susceptible of slight motion, strictly in the plane of the wing, the outer alone allowing a very slight lateral deflection. There is no possibility of any rotation at either of these joints, so long as the ligaments binding them together are not lacerated. A slight loosening of the ligaments will give the apparently wide range of motion shown in the preparations exhibited at the meeting of December 19th. The slight motion furnished by the two joints in the hand facilitate the close shutting of the primaries when the wing is folded, and their complete extension in flight.

The muscles which enter into the mechanism of flight are numerous and complicated. The large muscles, seated upon the sternum, which act upon the humerus and elevate and depress the whole wing in flight, need not be considered in this connection. The muscles of the wing proper are about twenty-five in number, and will be briefly reviewed. They may be divided into three sets; first, those of the upper arm; second, those of the forearm; third, those of the hand. Those of the upper arm having no special bearing on the present discussion may be passed over without further notice. The muscles of the forearm are ten in number, as follows:

1. *Flexor carpi ulnaris*, having its origin at the internal condyle of the humerus, and its insertion on the ulna at the wrist. Its important function is to keep the cubitus and metacarpus firm at any desired angle, besides preventing a too strong extension of the metacarpus.

2. *Musculus ulni-metacarpalis ventralis.*—Originates on the ulna, and is inserted on the second metacarpal. Aids the preceding muscle, and tends to draw the metacarpus down.

3. *Musculus ulni-metacarpalis dorsalis.*—A short muscle, originating on the ulna and inserted at the carpal end of the third metacarpal. Helps to flex the hand.

4. *Extensor metacarpi radialis.*—Originates on the upper outer condyle of the humerus, and is inserted on the first metacarpal. Helps to extend the hand.

5. *Extensor metacarpi ulnaris.*—It has nearly the same origin as the last; is inserted on the second and third metacarpals, and draws the hand down towards the forearm.

6. *Flexor digitorum sublimis.*—Originates at the internal condyle of the humerus, and is inserted on the digits, which it helps to flex.

7. *Flexor digitorum profundus.*—Originates on the inner face of the upper third of the ulna, and is inserted into the second or terminal phalange of the long finger, which it helps to extend.

8. *Extensor digitorum communis.*—Originates on the head of the humerus, and is inserted on the basal phalanges of the first and second digits. It draws the first finger against the second, and also helps to extend the second finger.

9. *Extensor pollicis longus.*—Runs from the inner edges of the upper third of both ulna and radius, and acts on the so-called thumb.

10. *Extensor indicis longus.*—Runs from the middle of the radius to both the first and second phalanges of the third finger, both of which it extends, and at the same time opens the six outer primaries, independently of the extension of the metacarpus.

We come now to the muscles situated wholly within the hand, eight in number. The new muscle claimed by Prof. Trowbridge is situated, if I am not mistaken, in the hand, and occupies the space between the metacarpal bones, which space it quite fills. I clearly understood this to be the muscle in question, and if so we may be able to identify it. Continuing with the enumeration:

11. *Musculus interosseus dorsalis.* A small muscle attached to the inner side of both the second and third metacarpals. It extends the phalanges of the third finger.

12. *Abductor indicis.*—Runs from the outside of the second metacarpal to the base of the first phalange of the second digit, helping to extend it.

13. *Flexor pollicis.*—Originates on the upper part of the second metacarpal, and runs to the base of the thumb.

14. *Abductor pollicis.*—Another thumb-muscle, to the movement of which its function is strictly related.

15. *Musculus interosseus palmaris.*—Originates along the

internal surface of both metacarpals, and is inserted into the base of the second phalange of the middle digit, a slip sometimes extending to the tip of the digit. Its function is to bend the terminal phalange of the middle finger, which runs to, and forms the tip of the bony framework of the wing. This is Prof. Trowbridge's new muscle.

16. *Extensor pollicis brevis*, and 17. *Adductor pollicis* are small muscles concerned alone with the thumb.

18. *Flexor digiti tertii.*—Originates on the third metacarpal and is inserted at the base of the third digit; helps to flex the second and third fingers.

In addition to these eighteen muscles, present in most birds, a little bundle of muscular fibres runs from the outer edge of the ulna to the base of each of the secondary quills. These little quill muscles are named by Sundvall *Rector remigum cubiti.* No muscles, or even muscular fibres, are in any way connected with the primaries. Those running to the secondaries act as a stay, and greatly strengthen their attachment to the ulna, to which they are affixed merely by their extreme base. No such provision is necessary in the case of the primaries, which are deeply imbedded in firm tissue.

This concludes my brief synopsis of the muscles of the wing, for aid in compiling which, and for a tracing of one of the best drawings of the wing-muscles extant, I am indebted to my friend, Dr. Leonhard Stejneger, of Washington, one of the most eminent and scholarly ornithologists of the day. The literature of this part of the subject is simply immense; the minute anatomy of the wing having been the subject of numerous elaborate special memoirs in various languages, running back for more than a century. The best authorities on the subject are German and Scandinavian, and, so far as I know, their works are not accessible in the libraries of this city. Not being able to find the works here I wished to consult, I was compelled to appeal for assistance to my friend Dr. Stejneger. Preschtl, in 1846, published a very elaborate memoir on the anatomy of birds' wings, on which my synopsis is mainly based.

In the present state of avian anatomy, it is extremely rash for any one to claim the discovery of a new muscle in the wing, or in any other part of a bird's body, till he has made himself thoroughly familiar with the work of his predecessors. In illustration of this point, I may say that a certain writer on the anatomy of birds, who has published more pages of text and many more and finer anatomical drawings than any of his contemporaries, has twice had the mortification of finding his alleged discoveries in the anatomy of the wing shown to have been made years before he ever put pen to paper. Dr. Coues's brief

treatment of the muscles of birds in his excellent "Key," is stated by the author himself to be of the most general character; and, accordingly, only a few of the most important muscles concerned in flight are mentioned, no attempt being made to treat the anatomy of the wing in detail. His single figure illustrating the myology of a bird shows only the outer side of the wing, while the new muscle occurs on the inner side, and therefore could not be shown in Coues's figure. Hence the statement that the alleged new muscle is not given by Coues is perfectly correct. It was first made known, however, as my friend Dr. Stejneger informs me, by Vicq d'Azyr, in 1773, or one hundred and fifteen years ago, and has been re-described many times since in the works, too, of such standard authorities on anatomy as Tiedemann, Heusinger, Meckel, Schöpfs, Preschtl, Milne-Edwards, Selenka, Gervais, Alix, and many others.

* * * * *

The structure of the feathers, their position and relation to each other, forbid any voluntary interlocking of the primaries; interlocking can be effected only by accident or artificial means. The primaries, as already stated, are so constructed that the inner vane of one feather supports and strengthens the outer edge of the next, and combines with it to form a resisting surface, impervious to air when the downward stroke of the wing is made. The barbs which form the vanes of the feathers are provided with recurved hooks which interlock so as to strengthen the vanes themselves. All the open part of the quills near their insertion is covered, both above and below, with smaller rigid and compact feathers, the more effectually to resist the air. Any overlapping of the quills in the inverse order not only rumples and impairs the inner vane, but lets the air pass between the feathers, and weakens the sustaining power of the wing. These points are not only well known, but are dwelt upon in numerous special papers on the flight of birds, as well as in many ornithological and anatomical works, as giving the wing its peculiar efficiency as an instrument of flight. In the downward stroke of the wing no air passes through, while in the upward stroke the air finds easy passage between the vanes of the feathers.

An important point not yet alluded to in this discussion is the fact that the quills cannot be interlocked when the wing is fully extended; it must be more or less relaxed to bring the outer quills near enough together to even touch at the tip, where the interlocking is especially claimed to occur. It is a matter of observation, confirmed by the experience of every observer who has carefully noted the flight of soaring birds, such especially as the turkey buzzard, eagles, and hawks, that the

sky can be clearly seen between the tips of each of the four or five outer primaries, which do not touch each other for several inches.[1] Furthermore, when the wing is flexed sufficiently for the tips of the primaries to overlap, the carpal bones have so far changed their position that they no longer "lock" the wing, if indeed that be their function under any circumstances. So that, could any advantage be derived from the interlocking of the quills, the other alleged conservator of muscular force, the interlocking of the bones of the wing, would be sacrificed.

It has been intimated that the emargination in the primaries of hawks and other soaring birds gives evidence of interlocking, being apparently a provision for this purpose. That it has suggested the theory of interlocking is quite evident, but it has no further bearing on the subject. That it is not distinctively characteristic of soaring birds has been abundantly shown. The purpose of this structure evidently varies in different birds.

In some birds, as the woodcock, various genera of pigeons, fly-catchers, and humming-birds, the falcate tips of the outer primaries give rise to musical sounds, of somewhat varying character in different species, due to the rapidity and angle with which they strike the air in rapid flight, the emission of the sound being voluntary on the part of the bird, and often forming a part of its amatory demonstrations, as does song or certain peculiar notes in many song-birds. In herons, many water-birds, hawks, eagles, owls, vultures, etc., it is apparently the elimination of a part of the vane which, if present, would prove only an impediment and an obstruction in flight. The emargination extends, it will be observed, from the point where, in the fully extended wing, the inner vane fails to fill the entire space between two contiguous quills. The vane becomes very weak and flexible along its edge, and requires the support of the overlying feather to keep it smooth and intact, so that were the vane to retain its full width to the tip of the feather, on which the air impinges with the greatest force in flight, it would have no support from the contiguous feather, and would be too weak to resist the air; it would consequently be more or less rolled upward at its free edge and prevent the free closing of the tips of the feathers; it would not be firm enough to give much sustaining power, would be in the way, and become folded and rumpled in the closing of the wing. Therefore just that useless and obstructive portion is the part eliminated by the

[1] A freshly killed specimen of the red-tailed hawk (*Buteo borealis*) was here shown in illustration of the point that the tips of the primaries cannot be in contact in the expanded wing of a soaring bird, and that consequently the alleged interlocking is impossible.

emargination of the vane. To give the portion of the vane thus cut away sufficient strength and breadth to add its share to the sustaining power of the wing, the vane would have to be thickened to make it more rigid, and broadened to fill the wide interval between the tips of the feathers, thus making a heavy club-shaped clumsy tip to the feather, and obviously decreasing the efficiency of the wing as an organ of flight.

Further evidence of the pertinency of this explanation of emargination is afforded, when we recall the fact that emargination is confined to a certain type of wing, and that when absent the wing is of an entirely different type as regards its general form. The wing of the frigate-bird well illustrates the form of wing in which there is no such emargination. It is a very long, acutely pointed wing, in which the first primary is the longest, the second, third, and all of the following being successively shorter, and all sharply pointed, so that when the wing is fully extended there is practically no open space between the tips of any of the primaries.

There are three principal types of wing in relation to its form:

I. A very long, pointed wing, in which the first primary is the longest, and all the outer primaries are narrowed toward the tip, and successively decrease rapidly in length, rendering no emargination necessary. Examples: man-of-war bird, albatrosses, shearwaters, gulls, terns, plovers, sandpipers, swallows, swifts, etc.

II. A short, rounded wing, in which the tip is formed by the four or five outer primaries, which are sub-equal in length. Here, owing to the shortness of the wing, the tips of the primaries are not separated when the wing is fully extended. Here no emargination is necessary, and none exists. Examples: sparrows, and the smaller song-birds in general; also rails, quails, tinamous and many grouse.

III. A long, pointed wing, but in which the tip is formed not by either the first or second primaries, but by the third, fourth, and fifth, and in which the six or seven outer primaries form the point of the wing, and are graduated in length from the longest, which is about the fourth or fifth, outwardly to the first, and inwardly to about the seventh or eighth. This form of wing is typically exemplified in hawks, eagles, buzzards, vultures, ravens, crows, etc.

Between these types of wing there is every stage of intergradation, with corresponding variation in the emargination of the primaries, in the form of wing characterized by this structure. The true falcons have a very pointed wing, in which the longest primary is the second; the first is somewhat shorter, and is the

only quill showing emargination. In this the emargination is slight, and extends for only about two inches. If we remove the first primary, we have a wing in which the outer primary is the longest, the next succeeding primaries being each shorter than the one next in front, resulting in a long pointed wing, in which the primaries are narrowed toward the tip, and recede successively in length, giving the same form of wing we have in the man-of-war birds, in swallows, swifts, humming-birds, night-hawks, etc., in which there is never any emargination.

Again, the emargination varies in extent, being limited in many birds to the first primary alone, and to the extreme apical portion of this; in others it occurs on the apical portion only, say for two to four inches of perhaps the outer four to six primaries; while in very many birds, including the turkey buzzard and its allies, and many hawks, it extends to the basal third or fourth of all the outer primaries.

Having now shown that interlocking does not and cannot take place, it may be worth while further to point out that it is unnecessary.

In a soaring bird, no great muscular tension is called into action. The large pectoral muscles, which move the wings up and down, are in a state of equilibrium, and under very slight tension, not more than are the muscles of a man's arm when the arm is in an ordinary position of rest. The mechanism of the bony framework is such, as has been already shown, that the wing is kept extended in such a way that there can be only very slight strain on any of the numerous muscles of the wing itself. The extension of the primaries is automatically effected by the extension of the wing, and results in no special strain, when once the wing is fully extended, upon any of the muscles whose function is to flex and extend the outer or phalangeal segments of the pinion. Hence the comparison made at the meeting of December 12th, of a man's arm held extended at a right angle to the body, in an unnatural position, with a bird's wing held extended in soaring, in a perfectly natural position, was wholly irrelevant.

The hypothesis of the interlocking of the primaries during protracted soaring, to conserve energy and lessen fatigue, has not only no basis in fact, but is entirely gratuitous.

DISCUSSION.

PROF. TROWBRIDGE said that he still adhered to his belief in the rotation of the manus, and the interlocking of the tips of the first three or four primaries, and was confident that the ornithologists would eventually admit it.

PROF. ALLEN replied that, according to anatomists, the bird's wing was constructed to guard against any rotation. He stated that the emargination could not be the result of wear, as it was present while the feathers were still in their sheaths; also, that the interlocking of the feathers, or crossing of the vanes, would cause a permanent crumpling or wrinkling of the vane, but that hundreds of wings of hawks in the American Museum showed the edges of the emarginated vanes smooth, straight, and perfect; that where they had been crossed by accident, the wrinkling indicated it.

PRESIDENT NEWBERRY briefly reviewed the debate, explained some misunderstandings, and pleasantly closed the discussion.

January 16, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Forty-two persons present.

The PRESIDENT exhibited a large specimen of *Edestus*, and photo-engravings of the same. He reviewed the discussion over the character of the fossils, and stated his belief that they were spines. He read by title a paper

ON THE GENUS EDESTUS.

(Published in the Annals, Vol. IV.)

MR. W. GOOLD LEVISON read a paper

ON A METHOD FOR THE ABSOLUTE MEASUREMENT OF THE SHUTTER-SPEED IN INSTANTANEOUS PHOTOGRAPHIC EXPOSURES.

(Illustrated with lantern views and results of experiments.)

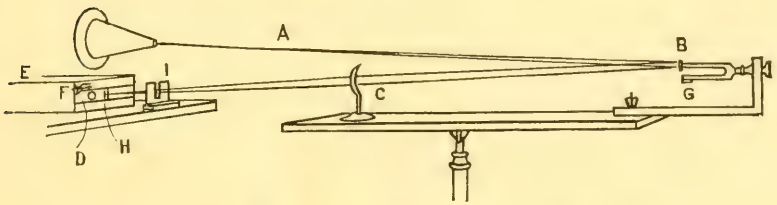
An accurate yet simple method for determining the duration of instantaneous exposures has long been desired by those interested in photography, especially in its astronomical applications; and an experience of this necessity has led me to contrive

a method which may perhaps become available. In adopting as a measure the vibrations of a tuning-fork it resembles the method of Mr. Albert Londe,[1] from which it differs in dispensing with a standard source of light, and in avoiding the complications arising from the individual equation of lenses, by determining directly the speed and rate of translation of the shutter, and therefrom the shutter exposure, which is a positive element of quick exposures.

By a combination of the two methods it would appear that the essential elements of an instantaneous exposure may be quite accurately determined, for while Londe's method deals with the lens, mine more particularly relates to the shutter. Certain principles which appear to be common to a large variety of shutters have been established by the first application of the method to the ordinary guillotine shutter. The term guillotine shutter, borrowed from the French, is herein used to designate any sliding shutter actuated by gravitation or a spring, whether it move downward, sideways, or upward.

Instead of the elaborate apparatus of Londe, a beam of sunlight, a tuning-fork, and a lens, constituted the easily arranged apparatus I first employed, which may, doubtless, be reduced to a portable form of such simplicity that any one may use it at a

Fig. 1.



moment's notice. By means of the diagram, Fig. 1, it may be explained as follows:

By reflection from a mirror, *B*, fixed upon one arm of a tuning-fork, a beam of sunlight, *A*, from a heliostat, is directed in a dark room through a meniscus, *C*, which projects it as a minute but brilliant spot, upon the shutter, *D*, of a camera, *E*. A counterpoise to the mirror must be fixed upon the opposite arm of the fork, and then its rate be determined.

The method as conducted with the apparatus is as follows: Upon the shutter *D* a light sensitive plate or film is fastened,

[1] Albert Londe, La Nature, May 19 and 24, 1887.

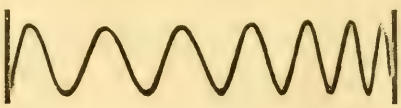
and then the fork being caused to vibrate by a violin bow, the spot of light swings in a vertical line, H, which is impressed upon the film. The shutter is then released by the catch *F*, and, as it flies along its course, the vibrating spot of light traces a sinuous line upon the film, until the shutter reaches the end of its excursion, when a second vertical line is traced. When the film is developed these lines appear, defined with an accuracy which depends upon the smallness of the spot of light and the care taken in performing the experiment.

The rate of the fork being known, both the velocity and rate of progression of the shutter may be directly determined from the number and proportionate width of the complete undulations between the two vertical lines, and the measured distance actually traversed by the shutter. The latter would correspond to the distance between the two vertical lines, but for a slight expansion of the film, which sometimes occurs during development, and may increase their separation. The discrepancy is so slight that it may be almost disregarded; moreover the correction for it is very simple, and even this may be avoided, by the use of a thin plate instead of a film.

Over a year ago I made a shutter to which was affixed a plate-holder for holding a sensitive plate, and I tried to employ a lamp as the source of light. But the shutter was too heavily weighted by the plate, and the lamplight spot made no impression on the plate. Recently, I was presented with a supply of the French "Perron" films, and having provided means of using a beam of sunlight, I soon attained successful results. I find that a spot of quite intense sunlight is required, because its actual duration upon the film at any one point during the transit of the shutter is very brief, yet, I have no doubt, a lamp will be eventually employed. The film referred to is so light that its weight may be disregarded.

Fig. 2 represents a film thus treated and developed. It

Fig. 2.



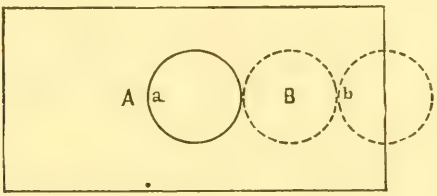
moved with the shutter from left to right. Counting as one vibration each undulation to and fro of the sinuous line, the number found between the vertical lines is about seven. The fork used was an E fork, a shade flat, and its normal rate is not accurately known, but it was rated by the maker at 331.25 vibrations per second, when loaded with about 1032

milligrammes on each limb. The seven vibrations divided by the rate of the fork gives directly the $\frac{1}{47}$ of a second as the time required by the shutter to fly 4.75 cm., which is the actual distance traversed by the shutter, though the distance between the vertical lines is a millimetre or two greater, owing to the expansion of the film. From these data the velocity of the shutter is easily calculated. The time of exposure, which is another matter, may be found quite as easily by methods which vary in different cases.

As an illustration, take first the case of a shutter of inconsiderable thickness, having an opening of 1.905 cm., and passing close behind an exposing aperture of the same diameter. First must be determined the distance the shutter must traverse to open and close the aperture. That this distance is in this case 3.81 cm. or twice the diameter of the aperture is shown by the diagram, Fig. 3.

A. The shutter. *B*. The exposing aperture. To complete

Fig. 3.



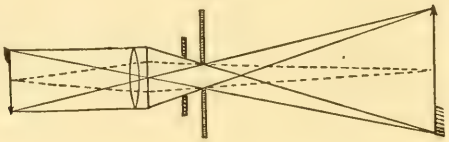
an exposure the side A of the shutter opening must move from *a* to *b*, twice the diameter of the aperture.

In order, therefore, to determine the time of exposure in this case, measure 3.81 cm. upon the film Fig. 2, by taking 1.905 cm., plus half the gain by expansion in each direction from a point midway between the vertical lines. 4.75 waves can be fairly counted in the 3.81 cm. so located, and these divided by 331.25 vibrations, the rate of the fork, give $\frac{1}{70}$ of a second as the time of exposure.

If, however, the shutter be not of inconsiderable thickness, or not close against the exposing aperture, other considerations are involved. Suppose, for instance, we have an exposing aperture of 1.27 cm. before a simple achromatic lens, and a shutter opening of 1.9050 cm., but have the shutter so far behind the diaphragm, as shown in Fig. 4, that when the openings are superposed the diverging rays entering the aperture just fill the shutter opening. The case seems practically the same as before, because the shutter must still move 3.81 cm. from the beginning

to the end of an exposure, hence, the same calculation, perhaps, applies. This is about the arrangement in a camera I have used

Fig. 4.



a great deal, and the exposure so calculated, the $\frac{1}{70}$ of a second is about my slowest average instantaneous exposure.

In the following table the information afforded by the film, Fig. 2, is condensed.

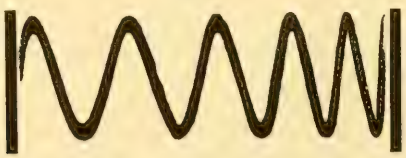
Slow shutter, 0.8 cm. headway. Rate of fork, 331.25 vibrations per second, at T. 23° C. Variation, about $\frac{3}{50}$ vibrations per degree.

Film shows 7 vibrations to 4.75 cm. 4.75 vibrations to 3.81 cm. $\frac{7}{331.25} = \frac{1}{47}$ of a second. Velocity of shutter $= 47 \times 4.75 = 2{,}132$ metres per second. $\frac{4.75}{331.25} = \frac{1}{70}$ of a second exposure.

A railway train at 50 kilometres per hour = 833.33 metres per minute, 13.88 metres per second, and 19.8 cm. in $\frac{1}{70}$ of a second exposure. The velocity of the shutter is about $\frac{1}{6}$ the velocity of the train.

In the case of a medium exposure with the same shutter the film, Fig. 5, is obtained. Between the vertical lines there are

Fig. 5.

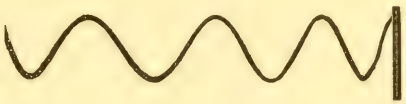


$5\frac{1}{2}$ undulations, and in the middle 3.81 cm. there are 3.75 undulations. These data afford an exposure of $\frac{1}{88}$ of a second, during which the railway train moves 15.77 cm., and a shutter velocity of 3.048 metres per second, which is about $\frac{1}{5}$ the velocity of the train.

Finally, with the same shutter and a quick exposure, the film,

Fig. 6, is obtained, affording 4 vibrations between the vertical lines, and $2\frac{1}{2}$ undulations within the intermediate 3.81 cm., which indicates an exposure of $\frac{1}{133}$ of a second, during which the train would advance 10.4 cm., and a velocity for the shutter of 3.933 metres per second, which is about $\frac{1}{4}$ the ve-

Fig. 6.



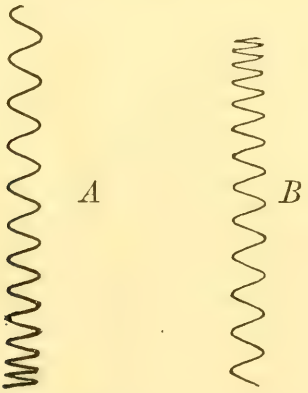
locity of the train. Other cases can be estimated quite as easily.

In these cases the distinction between slow, medium, and quick is that which is customary in the actual use of the shutter employed in these experiments. The shutter is, however, not uncommonly driven at a greater speed than that indicated in the latter of these cases, in which, as being selected at random simply to illustrate the method and not for the comparison of exposures, other details are omitted.

The relative velocities obtained by springs of different tensions and kinds, and by shutters of various designs, are now the subject of investigation, and will be given in a future paper, but to other indications of the experiments already tried we may now advert.

I have long been satisfied that the motion of a shutter ac-

Fig. 7.



tuated by a retractile spring is accelerated like that of a falling body, but in greater proportion, and each graphic record of the shutter's motion infallibly confirms my deduction. In Fig. 7 *A*,

is presented the register of a common guillotine shutter, actuated by a pair of light rubber bands (No. 33 Faber), and falling through a distance of 12.5 cm.

The acceleration increases to the end of the shutter's excursion, although it is restricted in this case by a retarding spring, which I omitted to remove, and the rubber bands are so attached as to be hardly stretched beyond normal length before the shutter is set.

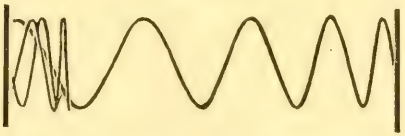
The entire number of undulations is about 12, the opening in the shutter is 4.1 cm., twice which linear measure, plus a correction for expansion of the film, makes 9.2 cm., which, at the middle of the record embraces 7 waves, and gives $\frac{1}{17}$ of a second as the time of exposure, for an aperture 4.1 cm. in diameter. If it were desirable, the time of this exposure could be reduced by so constructing the shutter that its top would run nearly to the lens opening and the exposure occur at the last moment. To demonstrate experimentally this acceleration, I some time since suggested a ribbon shutter, designed to operate with a headway of 50 cm., more or less, before exposure. No experiment is now required to assure us of the efficacy of such a shutter. More rapid exposures can undoubtedly be secured by increasing the headway of the shutter, with a given tension, quite as advantageously perhaps as by increasing the tension, especially beyond exposures of the one hundred and fiftieth of a second.

It might be supposed that the acceleration of the large shutter shown in Fig. 7 *A* is due in part to gravity. By its side (Fig. 7 *B*) is a record of the same shutter caused to fall (?) upward by the same spring tension. The difference in length arises from the difference in expansion of the films. In the number of undulations its upward is, perhaps, not quite the same as its downward record, but in the acceleration the two are nearly identical. In the *British Journal of Photography* for 1887, page 205, Mr. Richard Parr, reasoning from certain experiments, recommends an upward falling shutter as giving greater exposure to the foreground and less to the sky. His deduction is supported by the graphic evidence herein presented, that in ordinary shutters of moderate headway the first half of the exposure is longer than the latter half, and that even in the more advanced stages of the shutter's excursion a progressive acceleration still occurs.

In Fig. 8 is presented the record of another shutter. It is lighter than the one first used, being made wholly of pasteboard, and it was drawn by a thin rubber spring, 9 cm. long, stretched in a line with the shutter to 19.1 cm. Our attention is immediately drawn to the peculiar doubling of the undulating line

at its termination. This is caused by a rebound of the shutter, although it struck against a felt stop. This rebound could not occur in the three cases first presented, because a spring catch prevented it. This catch I have used for a long time in a hand camera, especially when making rapid exposures, because I found that in such cases the rebound might be sufficiently great

Fig. 8.



to cause a partial reopening of the aperture, and a double exposure.

Through the maze of its vagaries we can, however, easily follow the primary line. This is one of four exposures made at different times, with considerable intervals between. The shutter opening, and exposing aperture, were about the same as before, namely, 1.9 cm. in diameter. In all the films, as in this, there are about $4\frac{1}{2}$ undulations between the vertical lines. All these films expanded in different degrees, but, allowing for the expansion in each case, there are about $3\frac{1}{4}$ undulations in the middle 3.81 cm. From this it appears that the rubber springs do not change materially during short intervals.

These latter experiments were made with a fork of undedetermined rate, loaded with a much larger mirror than that formerly used. The camera with which they were made was so constructed that two shutters, very nearly alike, one in the usual place, the other in the focus of the lens of the camera where the plate should register, are simultaneously released, and being actuated by similar springs, stretched to the same extent, cross the camera in very nearly, if not exactly, the same time. The four exposures last referred to were made with films upon the front shutter, in the manner previously described; but in connection with two of them, one of which is the one shown, supplementary exposures were made, to which a moment's attention may be given. For each of these the camera was relocated, so that the beam from the mirror on the fork fully covered the opening of the lens, which focussed it to a point on the inner shutter. Upon this, in each case, a film was then fastened, and an exposure made while the fork was vibrating, both shutters moving together, but no film being upon the front shutter. These exposures were made in reality by the front shutter; the motion of the back shutter, which merely served to draw out the wave

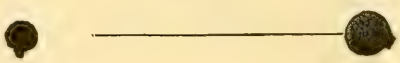
line, might have been slower or faster, perhaps, without affecting the result. The record obtained in each case is a line showing nearly three waves, and closely corresponding in this respect to the front shutter records, but tapering to infinity at either end, precisely like the lines obtained by Londe.

One of these records is shown in Fig. 9; and beyond the end of

Fig. 9.

the primary line is seen a supplementary figure, which indicates a double exposure caused by the rebound of the front shutter, and an almost simultaneous rebound of the back shutter. With rapid shutters, the absence of this indication without the spring catch is exceptional. By the symmetry or distortion of this figure, the relative movements of the two shutters may be inferred. From these records it appears that the inner shutter contains very nearly the same number of undulations and indicates very nearly the same time of exposure as that upon the outer shutter. They are made separately, and as absolute constancy in the rubber spring can hardly be expected, a slight difference between them might occur. But tapering as it does to infinity at each end, the line in the last record indicates that the effective exposure with the lens employed is somewhere about one-eighth or more less than the shutter exposure, for the light which so faintly depicts that proportion of its terminals would constitute but an indifferent proportion of the total actinic effect on the plate. In this case, a surplus of light was used, and Londe has shown that this line, descending as it does in intensity from an intermediate maximum, would reach infinity, and terminate, with a weak light, further from both the beginning and end of the exposure. This relation between the lens and the intensity of the light may be shown, perhaps, quite as well without a vibrating beam. In Fig. 10 is an actual record of an immovable point of light upon

Fig. 10.

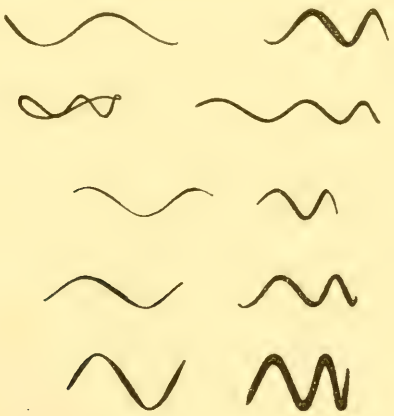


the inner shutter, the black spots indicating the limit of excursion of the shutter having been first made by special exposures. To draw comparison between two different records thus obtained, however, the velocity of the back shutter must remain unchanged.

From these indications we may advance into the realm of speculation, and, perhaps, discern a possible means of adjusting an exposure by a scale of tensions to the available light. To do this, we should, perhaps, determine by Londe's method the number of undulations traced by the lens upon the back shutter, by a front shutter exposure determined by my method with a full light. Then with a medium light slow up the front shutter until by successive exposures a similar number of undulations be obtained. Note the lesser tension required, and determine that corresponding to a light requiring the slowest exposure applicable to moving objects. The adjustment of the tension, which we now do by intuition, might possibly for that shutter and lens be thereafter done by a scale of actual velocities, only an invariable spring being required, and one element of uncertainty in instantaneous exposures be thus avoided. The shutters most generally used are, however, not simply drop shutters, but are so constructed as to move in an arc or circle, and in some cases within an enclosure which prevents the attachment of a film.

One of these shutters, reputed to be very rapid, consisting of two circular apertures passing in opposite directions, and opening and closing from the centre at the diaphragm of an optimus lens, I have examined by the modification of Londe's method last described, and the interesting records obtained are shown together in Figs. 11, 12, 13 and 14. Fig. 11 was obtained with

FIGS. 11, 12, 13, 14, 15.



a beam of normal sunlight. Fig. 12 with a beam of condensed sunlight, and both with a similar slow exposure. The double

exposure is always obtained, and is not much shorter than the primary exposure. My experience leads me to believe that a large proportion of the instantaneous shutters in the market are worthless, owing to this defect. The remedy for it is a large overlap to cover, or a catch to prevent the rebound. Neither of these precautions is usually provided. The effect of this double exposure upon motionless objects is to give a blurred picture, usually attributed to inaccurate focussing. A large proportion of failures, and the loss of many plates probably occur from this cause.

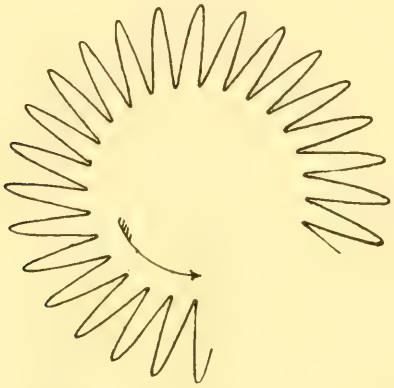
Fig. 13 was obtained with a beam of normal, and Fig. 14 with a beam of condensed sunlight, and both with the quickest action of the shutter that had been employed with that lens. In both the first and second pair of these four records, the defect of Londe's method, namely, its dependence on the intensity of the light, is at once apparent. To obviate this variable element, I removed the lens, and by so locating the camera that the beam from the meniscus, Fig. 1, focussed on the back shutter, passing centrally through the shutter opening, which enlarged in the plane of vibration of the fork, I obtained, with the same exposure, represented in Figs. 13 and 14, and a beam of normal sunlight, the record shown in Fig. 15. This appears to give the true time of the exposure, and seems to reveal an accurate and simple method, especially adapted for determining the time of exposure of any diaphragm shutter whatever. The velocity and expansion of the receiving film are matters of indifference. It is only necessary to divide the rate of the fork by the undulations obtained to arrive at the time of exposure which, in this case, is about $\frac{1}{147}$ of a second, obtained by dividing 331.25 by $2\frac{1}{4}$, a fair estimate, perhaps, of the number of undulations found in Fig. 15, which suggests that for closer reading of the more rapid exposures, a fork of much higher rate may be advantageously employed.

Instead of a sliding shutter, a rapidly rotating disk may be employed to carry the sensitive film, which, as the weight is then immaterial, may be a plate and the correction for expansion be thus avoided. By means of a simple multiplying wheel I obtained the record given in Fig. 16, of a Forrest "due ratio" shutter at a slow exposure, which was chosen in order to obtain nearly a circular tracing. It is evident, however, that by revolving the plate with sufficient rapidity the same result may be secured with any exposure. Rapid rotation may evidently be obtained by electro-magnetic devices, and either the duration of the exposure, or with a little calculation, the rate of rotation of the plate may be determined. If the weight of a plate would

defeat the latter purpose, the film may again be advantageously employed.

The entire avoidance of friction seems to render this method applicable as a new means of measurement, in many cases other than those relating to photography. It is hoped by its means to measure the duration of electric and lightning dis-

Fig. 16.



charges, and the flash given by various illuminants, such as magnesium powder and gun cotton.

The beam of light, however, must be adapted to the kind of shutters examined. In a central opening shutter, for instance, only a minute pencil of light entering the centre is necessary. But with an ordinary drop shutter, if such a pencil be used, it gives only the time occupied by the opening of the shutter in passing the point where the ray enters, irrespective of the size of the exposing aperture. In this case, the exposure may be accurately obtained by calculation ; but if a converging beam of light, filling the exposing aperture, be employed, the undulations obtained would probably afford a close approximation to the true time of exposure. With the assistance of this method, every shutter might be marked by the maker with a sequence of exposures, corresponding to certain tensions of the spring, and afford an additional guide and gratification to the user.

Exposures varying from the $\frac{1}{500}$ to $\frac{1}{5000}$ part of a second are not uncommonly mentioned. Mr. Edward Maybridge, in his circular of February, 1884, promised that verified exposures of $\frac{1}{5000}$ part of a second would be used. Some relation of the velocity of the shutter to the angular velocity of the moving object, accounts for the apparently sharp pictures that may be taken

at a distance, of an object moving at greater velocity than the shutter, and which at a less distance would afford but a blurred image upon the plate. This leads, perhaps, to many illusions respecting the rapidity of so-called instantaneous exposures. To obtain an exposure of $\frac{1}{88}$ of a second, with an almost frictionless shutter weighing only 8 grammes, under the conditions described, a strain of about 250 grammes was required; and to attain the $\frac{1}{166}$ of a second the strain increased to about 719 grammes, almost three times as much. The proportional increase required to reach the $\frac{1}{5000}$ of a second, were such an exposure attainable, may be imagined.

Since, with full sunshine entering the lens, however, the effective is so much less than the actual exposure, the difference with the weaker light used in practice must be proportionally greater, and we must not lose sight of the probability that our measures correspond to much shorter effective exposures.

The weather has afforded me no opportunity of taking test pictures with exposures specially measured by the method, but I have formerly taken many which compare favorably with those usually credited to very high exposures. Knowing nearly the tension used, I find by subsequent measurement that the shutter exposure employed was approximately the one hundred and seventieth of a second. The example, Fig. 17, will serve to il-

FIG. 17.

lustrate the relation of this exposure to a moving object finely lighted.

Should this method sustain a more critical study, and the exactions of scientific application, it would appear to be the hidden

key to several photographic problems, such, for instance, as the determination of the comparative efficiency or individual equation of lenses, and the proportionate exposures of various shutters.

The present contribution must terminate with acknowledgments to several members of the Brooklyn Academy of Photography for valuable assistance in promoting the advent of a method which appears susceptible of refinement in an eminent degree, yet for many practical purposes seems even in its crudest form to afford a sufficiently accurate measurement of an instantaneous exposure.

Remarks were made by MR. P. H. DUDLEY and MR. WILLIAM BARCLAY PARSONS.

January 23, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

A fair audience present, in the East Lecture Room of the Library Building, Columbia College.

The first lecture of the Popular Lecture Course was delivered by

PROF. W. LECONTE STEVENS on

THE DEVELOPMENT OF AERONAUTICS.

(Illustrated with lantern views.)

January 30, 1888.

STATED MEETING.

MR. CORNELIUS VAN BRUNT in the chair.

Thirty-five persons present.

PROF. J. S. NEWBERRY presented a paper[1] on

TRIASSIC PLANTS FROM HONDURAS.

In 1886, Mr. Chas. M. Rolker, a mining engineer and graduate of the School of Mines, brought from the vicinity of San

[1] In the absence of the author, the paper was read by Dr. N. L. Britton.

Juancito, Honduras, among other geological specimens, a small fragment of metamorphosed shale full of the impressions of the fronds of Cycads. As no Messozoic fossils had, so far as I knew, been brought from this region before, the discovery interested me much and I have since made earnest efforts to obtain other specimens from the same locality. Mr. Rolker kindly seconded these efforts and wrote to Mr. T. H. Leggett, E. M., also a graduate of the School of Mines, who is located at San Juancito in superintendence of a silver mine, giving him all the information he possessed in regard to the locality of the fossils. Mr. Leggett took up the search with enthusiasm, but until recently without success. A few weeks since I received a letter from him announcing the rediscovery of the plant beds and the shipment to me of a small box of fossils. This arrived last week and although the specimens are not numerous and the rock containing them is much weathered, they have furnished me some additional light upon the deposit which contains them. The plant remains are very numerous, closely packed together and the state of preservation leaves much to be desired, but they are significant and interesting and enable me to fix with a good degree of certainty their geological horizon. The species represented are briefly as follows.

1. A new species of *Zamites*, allied to *Z. occidentalis*, a fossil plant obtained by Mr. Remond, from the Upper Triassic coal-bearing rocks on the Yaki river, in Sonora, and described by me in the report of the San Juan Expedition, p. 152, Pl. V. This is much the most abundant fossil in the collection: the stipe of the frond is chaffy and the pinnules are set alternately on its upper face, and attached by their entire bases, which meet and completely cover the stipe. The pinnules are linear, from one and a half to two inches long, rounded at the upper extremities and traversed by numerous fine parallel nerves. The specimens of *Z. occidentalis* figured in the report mentioned above are all from the lower portion of the frond, and the pinnules are represented as attached to the sides of the stipe. Higher up their bases are brought nearer together and perhaps finally meet. Among all the specimens sent by Mr. Leggett none show well the lower part of the frond, and the characters given above are such as belong only to the upper portion. For this plant I propose the name of *Zamites Rolkeri*, thus connecting with it the name of its discoverer.

2. A species of *Zamites* similar to the preceding in general aspect, but having much narrower fronds and shorter and broader pinnules, which I name *Z. Leggetti*, in honor of Mr. T. H. Leggett who was the first to obtain it. It has also a somewhat different nervation ; in *Z. Rolkeri* the nerves are all simple, fine,

parallel with each other and with the margins of the pinnules; in *Z. Leggetti*, however, the bases of the pinnules toward the base of the frond are slightly rounded and narrowed and the nerves are somewhat divergent, bringing the plant nearer to *Otozamites* and into the same category with *Z. Feneonis*, Brgt. The two plants hold much the same relation to each other as *Palæozamia auctifolium* and *P. Cutchensis* of Oldham and Morris, "Fossil Flora of India," pp. 29 and 30, Pl. XXI. and XXII.

3. A species of *Pterophyllum* having very large and broad pinnules two inches or more in length by one inch in breadth, attached by the entire base, obliquely rounded at the other extremity and traversed by many fine, parallel nerves. This is closely allied to *Pterophyllum princeps* of Oldham and Morris ("Geological Survey of India," Pls. X. to XIII.) and *Pterophyllum Braunsii* and *P. Blasii*, Schenk ("Flora der Grenzschichten," Taf. XI.).

4. As pecies of an *Anomozamites* with narrow fronds, and nearly quadrate pinnules, of which the exterior and upper angle is somewhat produced. This resembles *A. Schaumburgensis*, Dunker ("Monog. d. Nord Deutsch. Wealdform," p. 15, Taf. I., II., VI.), but perhaps more closely *Anomozamites majus* Brgt. sp. which is from the Rhætic.

5. A fern too imperfectly preserved for satisfactory description or comparison. It has a bi- or tripinnate frond with narrow pinnæ and small, closely set falcate pinnules, resembling *Asplenites Ottonis*, Schenk, op. cit., Taf. XIV.

6. Traces of another fern are seen on some of the specimens, having narrow, linear pinnules with a single row of fruit dots on either side of the strong midrib. This is quite distinct from the preceding species and is not unlike some portions of the fertile frond of *Pecopteris bullatus*, Bunbury, so common in the Richmond coal field.

The plants enumerated above are so much like those with which they have been compared, all of which are from the Rhætic or Upper Trias, that I feel safe in the inference that the strata containing them are of that age.

The SECRETARY, in reply to inquiry, made a statement of the condition of the negotiations looking toward the union of the New York Mineralogical Club with the Academy, and PROF. D. S. MARTIN spoke of the desirability of co-operation and union among the various scientific societies of the city.

DR. N. L. BRITTON made an informal verbal report of pro-

gress in behalf of the Audubon Monument Committee, and exhibited the proposed design—a monolith in the form of a Runic

cross, with zoological and botanical decorative figures, an illustration of which is here given.

Contributions to the Audubon Monument Fund have been received from the following Members of the Academy:

Geo. N. Lawrence,	William Brewster,
Lawson Valentine,	J. V. Lauderdale,
J. S. Newberry,	L. W. Serrell,
Rutherfurd Stuyvesant,	John I. Northrop,
Carl H. Schultz,	Frederick Stengel,
Samuel Sloan,	W. H. Ingersoll,
Seth Low,	E. P. Thwing,
Hiram Hitchcock,	Henry Wheatland,
J. W. Gouley,	Joseph LeConte,
Joseph Lecomte,	Edward Orton,
John B. Ireland,	A. A. Wright,
W. P. Trowbridge,	F. A. Ober.

February 6, 1888.

REGULAR BUSINESS MEETING.

Dr. Alexis A. Julien (Corres. Secretary), in the chair.

Twenty-four persons present.

The Report of the Council announced the nomination of officers, in anticipation of the annual election, February 27th, 1888, and made the following recommendations:

I. The election as Resident Members of
Mr. John C. Henderson,
F. A. Mandeville, M.D.,
Edward H. Peaslee, M.D.

II. The payment of certain bills.

III. The adoption of the changes in the By-laws, proposed at the meeting of January 9th, which had been referred to the Council.

The candidates were elected by formal ballot, and the bills ordered to be paid. The changes in the By-laws were adopted after a long and spirited, but friendly discussion. Also the changes proposed December 5th, 1887.

Mr. Andrew Sherwood, Corresponding Member, communicated a paper on [1]

PREHISTORIC REMAINS FOUND IN TIOGA CO., PENN.

Clearings made and once occupied by the red men were found in this valley (the Tioga) by the first settlers; while implements of stone and fragments of pottery are ploughed up in several localities. When the first white man penetrated these wilds, there was in existence an Indian burial ground, which remained visible until after the year 1830, or until the construction of the Tioga railroad; its former location can still be pointed out by several of the older inhabitants, who remember seeing it. It was situated in a most romantic spot, just where the river enters the gorge below Lamb's Creek. The exact location is indicated by an elm tree, about twenty rods east of the bridge which crosses the river, and nearly half-way between the bridge and the old Israel Mann house. Both the wagonroad and the railroad now pass through it, so that it is entirely obliterated. It was originally marked by the Indians with a large stone slab set in the ground, some six feet in height, but containing no mark or inscription of any kind. The dead were buried in a sitting posture, and the mounds were round. Many pieces of pottery, as of kettles, etc., were found here when the railroad was built. Their largest clearing was at this place, which contained wild plum trees, bearing fruit in abundance after the place was known to the whites. Other clearings are described as having grown up to choke-cherry and other bushes, but with corn hills still visible.

A very high flood in the river in the year 1870 removed about a foot of soil, for a distance of several rods, from the surface of the main road at Lamb's Creek, where it is intersected by the road from the depot. This revealed a number of ancient fireplaces, where were found charred wood, fragments of bones, pieces of pottery, arrow-heads, pestles, stone wedges, and various flint implements—most of which I now have in my possession. The pottery was unique, having been baked from clay mixed with very small pebbles, and having the exterior rudely ornamented, all after one design, with rarely an exception, in which case the ware seems to have been made of clay mixed with fine sand and made smooth inside and out. The place must have been a camping ground, and the sand removed by the flood was doubtless placed there long before by the same agency.

At some period in the past, probably representing a greater antiquity than any remains mentioned above, there was a vil-

[1] The paper was read by Prof. D. S. Martin.

lage on the point of land southwest from the cemetery at Mansfield, Penn., now owned by the writer, and over which the cemetery is being extended. The place commands a fine view of the river valley up and down for many miles, and is by nature one of the most delightful locations in northern Pennsylvania. It is a neck of land, thirty or more feet in height, projecting from the terrace of drift which borders the river plain, and was covered with a heavy pine forest when first seen by the white man. It contains some five or six acres, and is rich in relics; the soil, which is a gravelly loam, having been originally filled with them. They were manufactured here from material obtained somewhere to the north, and one can readily detect the location of the wigwams or dwellings by the number of flint chips, etc., found in certain places. Implements, both finished and in a partially finished state, have been ploughed up during many years, and although the writer has collected many hundreds of them, the place is not yet exhausted, but continues to furnish specimens whenever the ground is newly ploughed. These were made in a number (but more particularly in two) places, at which were doubtless workshops or habitations. I have picked up over two hundred arrow points, a number of pestles, a number of polished implements used, evidently, in the dressing of hides, some stone axes, a large number of stones used as sinkers on fish-nets, as well as various other things, including several (probably ten), bushels of flattened sandstone cobbles. These cobbles average three or four inches through the broad diameter, and have round, pointed holes cut or pecked in one or both (generally both) sides, one-eighth to one-half inch in depth, and of which the accompanying specimens are good examples. The arrow points are mostly of dark-colored flint, and are as a rule very small, though not always so, and were, I have surmised, used and lost by boys in practising upon a mark. But one white one has been found, a beautiful specimen of fair size (which may have a history of its own), and a few of a yellowish, and some of a reddish color. There are three or four different styles represented; one made to fasten to the arrow in the ordinary manner, one made to give the arrow a revolving motion while passing through the air, and another—the poisoned point—made to insert into the end of the arrow without fastening, in such a manner that it could not be withdrawn without leaving the point imbedded in the flesh. The flattened cobbles referred to, with a hole picked in each side, are a riddle which I have not as yet been able to solve. Part at least if not all were evidently obtained from the river bed, where they have been washed down from the coal measure sandstones at Blossburg, ten miles above; but I cannot imagine what they were used for, or how the

holes were made. It would test the best of steel to make them, as they are composed of hard quartzose sand, yet I suppose it was done with flint.

In some instances there are two holes pecked in each side, and a few are found of a grayish and reddish sandstone, while occasionally there is a larger stone filled with the same kind of holes, as if they had been used for anvils. These last were evidently not brought from the river bed, but obtained on the spot, as indeed may have been the case with the cobbles.

It is very singular (to me at least) that not one of the cobbles has ever been found elsewhere in the vicinity, not even among all the relics found at Lamb's Creek, two miles and a half below. It is a matter of equal interest that not a single fragment, large or small, of the curious pottery found on the river flats, at points not half a mile away, and mentioned as occurring so frequently at Lamb's Creek, has ever been found at this place. The flint chips, arrow points, and these cobbles, I have found in some instances imbedded in the soil directly under large pine stumps, with which the ground was formerly occupied, and which I grubbed out a few years since. In two places where I had occasion to level the ground I found, a few inches beneath the surface, what appeared to be ancient fireplaces, with charred wood, bones, and arrow points.

February 13, 1888.

STATED MEETING.

Vice-President, PROF. O. P. HUBBARD, in the chair.

Fifty-three persons present.

DR. H. CARRINGTON BOLTON read the following paper:

PRELIMINARY NOTICE OF A NEW STUDY IN FOLK-LORE.

(Abstract.)

Dr. Bolton stated that he had begun to collect and investigate the *Terms Used in Talking to Domestic Animals*.

In controlling the movements of domestic animals by the voice, besides words of ordinary import, man uses a variety of peculiar terms, calls, and inarticulate sounds—not to include whistling—which vary in different localities. In driving yoked cattle and harnessed horses teamsters cry "get up," "click click" (tongue against teeth), "gee," "haw," "whoa,"

"whoosh," "back," etc., in English-speaking countries; "arre," "arri," "jüh," "gio," etc., in European countries.

In the United States "gee" directs the animals away from the driver, hence to the right, but, according to Webster's Dictionary, in England the same term has the opposite effect; because the driver walks on the right hand side of his team. In Virginia, mule drivers gee the animals with the cry "hep-yee-ee-a;" in Norfolk, England, "whoosh-wo;" in France, "hue" and "huhaut;" in Germany "hott" and "hotte;" in some parts of Russia, "haitä" serve the same purpose. To direct animals to the left another series of terms is used, such as: "haw" (U. S.); "who-haw" (Va.); "who-hysh" (Me.); "whoosh" (Suffolk); "har," also "hü" (Germany); "dia" (France); "vishtä" (Southern Russia).

In calling cattle in the field, a great variety of terms are used, of which the following are examples: "bos, bos" (Conn.); "sake, sake" (Conn.); coo, coo" (Va.); "sook," and "sookey," also "sookow" (Southern U. S.); "koeb, koeb" (Me.); "cusha" (Scotland).

In calling sheep, "konan," and "konanny" (Ga.); "k'day, k'day" (Conn.). In calling horses "kope" is common in the Southern U. S., and the Creoles of Louisiana cry "see-chuck." In calling hogs in the field "chee-oo-oo" (Va.), "pig-ooy" (Ill.), "chaw-awg" (Va.), "whoop" (Ga.), are some of the terms current in the localities named.

With the exception of whoa, gee, and haw, and some others, these words are not found in dictionaries, and the speaker proposes to form a vocabulary of them. In the cases of inarticulate sounds, chirps, and clicks, he adopts the notation of Professor A. Melvill Bell, author of "Visible Speech." Of this system and its application to the case in hand he gave illustrations on the blackboard.

Dr. Bolton gave examples of the terms used in Germany, France, Switzerland, Norway, Russia, Southern India, and among the Eskimo. He pointed out certain common features as well as some singular reversals; sounds used in one country to start and urge horses are used in another country, or even in another part of the same country, to stop them. He further gave quotations from early literature, and referred to the explanations occurring in certain English dictionaries of archaic and provincial words.

In conclusion, he stated that this should be regarded as a preliminary notice made for the purpose of asking assistance of persons interested. He is desirous of collecting words and

expressions (oaths excepted) used in addressing domesticated animals in all parts of the United States and in foreign lands.

In particular he seeks information as to:

(1) The terms used to start, hasten, haw, gee, back, and stop horses, oxen, camels, and other animals in harness.

(2) Terms used for calling in the field: cattle, horses, mules, asses, camels, sheep, goats, swine, poultry, and other animals.

(3) Exclamations used in driving from the person domestic animals.

(4) Any expressions and inarticulate sounds used in addressing domestic animals for any purpose whatever (dogs and cats).

(5) References to information in works of travel and general literature will be very welcome.

The speaker suggests that persons willing to collect these data may indicate the value of vowels in English by using the vowel signs of Webster's Unabridged Dictionary, and in cases of difficulty terms may be spelled phonetically. He stated that he would be grateful for contributions, oral or written, and that materials used in a future publication would be credited to the contributors. Correspondence should be addressed to him at the University Club, New York City.

Remarks were made by PROF. FREDERICK STENGEL and MR. L. E. CHITTENDEN.

DR. BOLTON read the following paper

NOTES ON THE GREAT SALT DEPOSIT OF PETITE ANSE, LOUISIANA.

(Abstract.)

The southern coast of Louisiana, west of the Mississippi River, is indented by several bays through which the waters of innumerable bayous pass into the Gulf of Mexico. Near the head of one of these bays, known as Vermilion Bay, there is a nearly circular island of about 2,500 acres in extent, which rises above the low marshes of the vicinity to the height of 180 feet, forming a notable feature in the monotonous landscape. This is the well-known island of Petite Anse, also called Avery's Island after its present owners, in which occurs a remarkable deposit of rock-salt. Petite Anse is now easily reached by rail, *via* the Southern Pacific Railroad, from New Orleans as far as New Iberia (about 125 miles), and thence, by a branch road, 10 miles long, to the salt mine. Cotton and sugar plantations, uncultivated fields, marshes, corn-fields, and cypress swamps alternate

with luxuriant forests of live-oak, gum, hickory, black walnut, cypress, maple, and magnolia. About two-thirds of the island are under cultivation, the most profitable crops being sugar, salt, and Tobasco pepper-sauce. Three ranges of hills can be traced, the surface water from which has cut its way deeply through the alluvial deposits, forming ravines, which, with ponds, forests, and cultivated fields, make the island a picturesque oasis in a desert of marsh and cypress swamps.

The existence of salt on this island has been known for a very long time, as shown by the fragments of pottery, arrow-heads, and basket work found mixed with bones of the mastodon, buffalo, and deer, unearthed in recent excavations. The written history of the deposit begins with 1791, when John Hays found a brine spring while hunting. In the last century, salt was made by boiling down the brine, and between the years 1812 and 1815 the amount produced was large. It then ceased for a time. Later, Judge D. D. Avery became owner of the island, and at the outbreak of the rebellion renewed operations on a large scale; the blockade made the salt exceedingly valuable, so that one time a bag of salt was exchanged for a bale of cotton. On May 4th, 1862, Mr. John Marsh Avery attempted to deepen a brine pit, and struck rock-salt at a depth of 16 to 17 feet below the surface. The Confederate Government then instituted mining by means of pits, and, 400–600 men being constantly employed, the island was a scene of prodigious activity. The Northern troops, however, seized the island April 20th, 1863, and put a stop to the industry. During these eleven months, about 22 million pounds of salt are estimated to have been taken out, the average price being 4½ cents per pound.

The first scientific observer who visited the deposit after these events was Professor Richard Owen in November, 1865 (*Am. J. Sci.*, July, 1866, p. 120). In 1866, Professor Charles A. Goessmann visited the place on behalf of the American Bureau of Mines ("Report of the American Bureau of Mines on the Rock-salt Deposit of Petite Anse," 4to, New York, 1867), and one year later it was examined by Professor E. W. Hilgard of the Geological Survey (*Am. J. Sci.*, Jan., 1869, and "Mineral Resources of the United States," Albert Williams, Jr., Washington, 1883).

To the reports of these gentlemen we owe some of the particulars of this notice.

The rock-salt lies only fifteen to twenty feet beneath the surface. The surface soil is a dark loam, beneath which occur layers of coarse and fine sand, gravel, and clay, all irregularly stratified and in no definite direction. The salt itself occurs as a massive crystalline rock of a saccharoidal texture, dry, hard, and homogeneous. It is of a white color, except in streaks

or bands two to six inches in width, which are quite black. The salt appears to have a uniform character in all parts of the mine, and is remarkable for its purity, especially in its freedom from calcium and magnesium salts. It is also quite free from potassium salts; for traces of Stassfurt salts I made especial search in vain. The following analyses show the great purity of this product:

Analysis by Mr. F. W. Taylor, (Smithsonian Institution) March, 1882.		Analysis by E. W. Hilgard. 1863.
Sodium chloride,	98.731	99.880
Calcium sulphate,	1.192	0.126
Calcium chloride,	Trace	Trace
Magnesium chloride,	0.013	
Silica,	0.024	100.006
Iron sesquioxide,	0.010	
Water,	0.030	
	100.000	

Other analyses made by Professor Goessmann range from 98.88 to 99.60. It is of interest to compare this with rock-salt from other localities.

	Cheshire.	Stassfurt.	Berchtesgaden.
Sodium chloride,	98.30	94.57	99.85
Potassium chloride,			Trace.
Calcium chloride,			Trace.
Magnesium chloride,	0.05	0.97	0.15
Calcium sulphate,	1.65	0.89	
Insoluble,		3.35	
Water,		.22	
	100.00	100.00	100.00

Partial analyses of the black salt have been made by Mr. McCalla, the resident engineer and chemist, who finds that it yields a white solution and about seven per cent of a white insoluble residue, chiefly gypsum. The black color, therefore, seems to be an optical phenomenon. These black bands form well-marked folds in the salt, the space between the ridges and above them being filled with coarser granules of salt than the rest. Near these black bands the finest cleavage crystals of transparent purity are found. These bands seem to indicate that at some time the rock-mass has been subjected to lateral pressure, causing ridges.

The geological features of the island and the origin of the salt deposit have been discussed by both Professor Goessmann and Professor Hilgard. The former thinks it is "probably of tertiary age," and says, "many circumstances favor the theory that the deposit is a secondary one—resulting from the evaporation of

brine springs, originating from beds of rock-salt in some older geological formation—and not a direct residuum of the sea. This explains the entire absence of intercalations of gypsum and the absence of potassium and magnesium compounds."

Professor Hilgard thinks it should be assigned to the cretaceous, since there is "no phase of the tertiary history of the Gulf of Mexico that seems to admit of" the conditions required, viz.: the long-continued evaporation of some very large body of sea-water. He calls attention to the banded structure of the rock-salt, and remarks that the "Stassfurt salts" belonging to the salt mass have long ago been washed into the general ocean.

We would call the attention of geologists to two facts which may throw light on the questions: the occurrence on the island of bedded sandstone and of lignite. The sandstone is exposed at the bottom of a deep ravine about 1,500 feet from the shaft, the rock is of a light gray color and contains little or no calcite. It is distinctly seen to be in place, and is weathered to a considerable depth beneath the surface. At the base of another ravine, formed by a rivulet cutting through the alluvium, gravel and sand, and at a distance of about 2,000 feet from the shaft, there is an outcrop of lignite. The latter is apparently several feet in width and of good quality for economic purposes. Mr. McCalla reports that it contains fifteen per cent of ash. Both the sandstone and the lignite seem to dip in such a direction (S. E.) as would cause them to run beneath the salt. This view is also confirmed by some of the borings. Indications of fossil plants occur in the brown coal, but at the time of my visit it was unfortunately impracticable to dig deeply into it, and I had to be content with a mere surface specimen.

There are four other islands stretching along the coast in the vicinity, but borings have failed to reveal salt on any of them.

The mine is now worked by a system of chambers and cross-headings. The single shaft has reached a depth of 166 feet (including the sump of 6 feet). The old workings at a depth of 90 feet have been abandoned, owing to the infiltration from above of water carrying with it clay and sand, which rendered the salt impure. The lower level is at a depth of 160 feet. The extent of the excavation in the upper level is about 8 acres, and the extreme ends of the galleries are 900 feet apart. The excavation on the lower level is much smaller. The method of operating is to run galleries about 6 to 8 feet high, and then to work upward to a height of 40 feet, leaving between the galleries large pillars to support the roof. The boring is done with a kind of auger of a German pattern, imported in deference to the prejudices of the workmen, who are largely Stassfurt miners. The auger is worked by hand and penetrates the salt one inch for

every 12 revolutions of the bit. The blasting is done with dynamite, of which 80 to 100 boxes, each containing 100 lbs., are used every month, say on an average 150 lbs. daily.

After blasting down 40 feet, the salt is broken by sledges, placed in small hand-carts, and hoisted on a platform to the surface by steam power. About one hundred men are employed by the company, of whom fifty work below the surface. They work on ten-hours time.

The rock mass is quite dry, but, owing to bad management in the early history of the mine, water from the surface runs into it through seams and openings; to remove this, two pumps, capable of throwing out 100 gallons per minute, are run about ten hours out of the twenty-four. The brine pumped out is allowed to waste.

Ventilation is necessitated by the great quantity of dynamite exploded daily. Air is supplied by a fan 8 feet in diameter, 4 feet wide, driven at about 250 revolutions per minute. This, it is estimated, supplies about 600,000 cubic feet of air per hour.

Pockets of an inflammable gas have been repeatedly struck, and on a recent occasion the issuing gas was lit and burnt for an hour or more. Perhaps this phenomenon is connected with the underlying lignite.

The engines used for running the blower, the fan, reels, breakers, etc., are three in number, and aggregate 250 horse-power.

The salt brought to the surface is crushed between corrugated rollers driven at high speed; one set breaks it into lumps from two to three inches in diameter, and another into lumps one-half inch in diameter and finer. It is then ground into various grades by six buhr-stone mills, each capable of grinding 50 tons in ten hours. The salt is sorted by jigs, revolving reels, and blowers, the fine dust being blown out by a horizontal current of air striking against a column of falling salt.

The salt is sent into market in eight grades: (1) Rock-salt in lumps from 100 to 300 pounds, used by farmers, it being placed under sheds for cattle to lick. (2) Crushed salt that passes over $\frac{1}{2}$-inch screens and through $\frac{3}{4}$-inch screens. (3) "Fish salt," including all which passes through a $\frac{1}{2}$-inch screen. (4) Coarse ground. (5) Medium ground. (6) Fine ground. (7) For sack and barrel salt the coarser particles of grade 6 are screened out with a wire screen of ten meshes to the inch, and the fine dust is blown out. (8) The fine dust thus blown out divides itself by gravity into an impalpable part (which is thrown away, being a small percentage) and a coarser part, which forms table salt. The salt is shipped to market in sacks and barrels.

For the year ending July, 1887, the product was 44,000 tons. In a busy season, the daily shipments run as high as 300 tons. Formerly the material was transported by water, through a canal expressly maintained for the purpose, into the bay some miles distant; now the railway carries it exclusively.

The amount of salt in sight is very great, and the possible extent of the deposit is enormous. Borings show that about 142 acres of ground are underlaid with salt, the extreme depth of which has not been ascertained, though borings have been sunk 190 feet. Everywhere the character of the salt is the same, and the mine is evidently destined to supply the market for generations to come. At present, the owners of the property have leased the mining privilege for a consideration to the American Salt Company.

[Specimens of sandstone, lignite, and salt were exhibited, the latter in transparent cleavage crystals some of which measured $4 \times 3 \times 2$ inches.]

ABSTRACT OF DISCUSSION.

Prof. E. T. Cox described a salt deposit in Kansas, 300 feet in thickness and 600 feet below the surface. In the Calcasieu districts, on a line between this and Petite Anse, were other salt beds and vast sulphur deposits beneath quicksand. A million dollars had been spent in trying to reach the sulphur. He believes that the Petite Anse salt and the Kansas deposit were of cretaceous age and of similar origin.

President Newberry spoke of the origin of rock-salt deposits. The most satisfactory theory was that of evaporation of great masses of sea water and the precipitation of the various chemical "salts" at different levels;[1] the pure salt being precipitated after the gypsum and before the other chlorides and sulphates.

In the alternations of level (12 feet) of Great Salt Lake, precipitations of minerals occurred which illustrated this theory. However, the formation of these deep deposits of salt was still in some degree a mystery.

There were evidences at Petite Anse of an ancient salt industry. But the association, in the old pits, of human remains with

[1] See article by Prof. Newberry in *Transactions*, vol. iv., p. 55. Ed.

the bones of the mastodon, might possibly be accidental, by the crumbling of the walls of the excavations.

The idea that the North American Indians did not use salt was incorrect.

The speaker related how, when the Ives' expedition to the Colorado ran out of salt, and all the food was unpalatable, that the Indians supplied salt brought from the Virgin River; and that they found salt springs on the Little Colorado which bore evidence of frequent visitation. He had, however, found the Ojibways, on the north side of the St. Mary's River, eating boiled whitefish without salt.

PROF. D. S. MARTIN exhibited one of two specimens of Petite Anse salt, which were the first brought to New York City. They were secured by a newspaper correspondent who accompanied the United States forces under Gen. Banks, which took the mine from the Confederates.

February 20, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Twenty-seven persons present.

The President read an announcement of the publication of *Annales de Géologie et de Paléontologie*, at Palermo, under direction of the Marquis Antoine de Gregorio. Of this, five parts have already been published.

PROF. D. S. MARTIN read a paper on

THE GEOLOGY OF NEW YORK CITY AND ENVIRONS.

The topic was discussed by PROF. O. P. HUBBARD, DR. N. L. BRITTON, and the PRESIDENT.

February 27, 1888.

SEVENTY-SECOND ANNUAL MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Thirty-four persons present.

REPORTS OF THE OFFICERS FOR THE PAST YEAR.

THE RECORDING SECRETARY'S REPORT.

Meetings.

The Council has held eleven meetings.

The Academy has held thirty-four meetings; every Monday evening during the season of the Academy sessions being occupied excepting one—that of Decoration Day.

There have been twenty-two Stated Meetings, which include four Popular Lectures; nine Regular Business Meetings; one Adjourned Business Meeting; one Annual Business Meeting; and one Special Business Meeting, held in August during the meeting of the American Association for the Advancement of Science.

Attendance.

The average attendance at twenty-eight ordinary meetings was forty, including visitors. Only one meeting had a smaller attendance than twenty. The Popular Lectures were greeted by the usual audiences. The meeting of November 7th, to which was invited the Local Committee, A. A. A. S., was a gathering of about three hundred persons. The Special Meeting, in August, held in the Library Hall of Columbia College, was attended by perhaps a thousand persons.

Membership.

The List of Resident Members numbers three hundred and two. During the year there have been twenty resignations and two deaths. Two persons have been changed from Resident to Corresponding members, and one from Corresponding to Resident. Twenty persons have qualified. It is a matter for congratulation that notwithstanding the raising of fees and dues from five to ten dollars at the beginning of the year, the number of members is but three less than last year.

Seventeen Resident Members have become Fellows, making eighty-four Fellows at this date.

Papers.

Forty-nine formal or announced papers have been read, as against thirty-one the previous year. These are grouped as

follows: Geology and Palæontology, eleven; Geography, seven; Mineralogy, seven; Zoology, six; Physics, four; Physiology, Meteorology, and Mechanics and Engineering, three each; and one each in Archæology, Botany, and Chemistry. The informal and oral communications have been numerous, as usual, and cover a wide range of topics. Detail is unnecessary here, as the Transactions make a full record of the scientific work.

Publications.

Volume IV. of the Transactions, which was required to make the series complete, has been printed and distributed.

Last year's volume, Vol. VI., has been recently distributed.

The matter for the first four months of the current year will soon be given to members. And it is intended that thereafter the publication of the monthly or bimonthly numbers of the Transactions will be prompt. To accomplish this, the co-operation with the editor of the authors of papers is necessary.

Changes of By-laws.

The only important changes of rules since the increase of Resident Members' charges, are the increase of the Patron's fee to $250, and the creation of the class of Life Members, with a fee of $100.

Review, and Events.

In all respects the year has been prosperous and successful, and in several particulars a year of special and unusual interest and activity.

The doubling of the membership charges made the year one of anxious interest. The result is gratifying, as shown by the undiminished membership and greatly increased income. (See Treasurer's Report.)

The publication of the *History of the Society* was an event of peculiar pleasure.

It was not by intention or desire that the Academy took the most prominent part in the preparation for, and entertainment of the American Association for the Advancement of Science. But circumstances so ordered it, and the successful character of the Association meeting reflects honor upon the Academy.

In the erection of a monument to Audubon, another movement of a public character has been initiated by the Academy, and is being successfully conducted by its committee.

The process of separation, and creation of special scientific societies, which has heretofore prevailed in the city, has been met by a reverse tendency; and in the proposition of the Miner-

alogical Club to unite with the Academy, the friends of science see indications of a movement which it is hoped may unite scientific effort and influence, and strengthen the Academy.

HERMAN LEROY FAIRCHILD,
Recording Secretary.

THE CORRESPONDING SECRETARY'S REPORT.

(*Summary.*)

The Academy is in regular correspondence, and exchange of publications, with three hundred and seventy-four American and foreign Scientific Societies throughout the world, as specified in the following table:

United States	108	Denmark	2
Canada	12	Norway	6
Mexico and West Indies	4	Sweden	8
South America	3	Russia	10
Great Britain	48	Switzerland	12
France	30	Portugal	4
Austro-Hungary	14	Spain	1
Germany	62	Italy	19
Belgium	8	India, Java, etc	5
Netherlands	8	Australia	9
		Japan	1

A copy of this new Exchange List has been published at the end of Vol. VI. of the Transactions.

As our former list included three hundred and thirty-one Societies, there has been a gain of forty-three in the total number. Eighty names of societies, institutions, persons, and journals have been dropped from the old list, because no longer in existence, or no longer in exchange with us, or because for other reasons their continuance was no longer desirable.

In answer to the circular of the Academy, proposing exchange and revision of our list, which was prepared and sent out in 1886, about one-third of the societies addressed have sent formal replies; about one-third have virtually accepted the exchange by their continued action; and replies are yet arriving every week up to date.

As a result of this circular, one hundred and twenty-three societies and institutions new to our exchange list have been included, nearly all of whom are now sending us their own publications. Many of these societies are very active and important, and their publications very valuable.

The list of Corresponding Members now numbers three hundred and twenty, of which seven names have been added during the year.

During several years the list of Honorary Members has fallen, by decease, below the constitutional limit, fifty; our most recent loss being that of Prof. Asa Gray. The recent election of ten Honorary Members has raised the number to forty-six, leaving still four vacancies.

ALEXIS A. JULIEN, *Corresponding Secretary.*

THE TREASURER'S REPORT.

NEW YORK ACADEMY OF SCIENCES IN ACCOUNT WITH HENRY DUDLEY, *Treasurer.*

From February 28th, 1887, to February 27th, 1888.

Dr. DISBURSEMENTS.	
Printing Annals and Announcements of Meetings	$412 44
Printing Transactions, Vol. IV	166 00
" " Vol. VI	387 70
" Miscellaneous	108 25
Expenses, Meetings, etc	101 09
" of Recording Secretary	8 40
" of Corres. Secretary and Librarian	95 88
" of Treasurer	7 69
" of Chairman of Public. Com., and editing Annals	188 90
Duty, freight, engraving	69 66
Wrappers	4 00
Collation	400 00
Cost of moving Library	87 50
10 copies of History of the Society	25 00
Overpaid dues returned	10 00
	$2,072 51

RECEIPTS. *Cr.*	
Balance from last year's report	$8 62
Annual dues	1,985 00
Initiation fees, 18..	180 00
Patron's fee	100 00
Fellowship fees	160 00
Sale of Publications	27 30
Publication fund	420 00
Temporary investment	200 00
Interest on U. S. 4% Bonds	164 00
	$3,244 92
Balance in Treasury	1,172 41
	$2,072 51

HENRY DUDLEY,
Treasurer.

THE LIBRARIAN'S REPORT.

The Library of the Academy has been shelved during the past year on the walls of the Herbarium Room of Columbia College, where it was placed in September, 1886. It is quite isolated from the main college library, the only other books in the room being those belonging to the college herbarium. It is open for consultation from eight o'clock in the morning until ten in the evening.

There have been added during the year by exchange and donation, 1,388 volumes, parts, and pamphlets.

Under the arrangement made between the Academy and the Trustees of Columbia College, all books received since the deposition of the library in its present quarters have been promptly bound. This statement applies as well to volumes only in part published at that time. In all 154 volumes have been bound at an expense to the college of $167.93.

The books have been roughly classified on the shelves, under subjects, preliminary to the preparation of a new card catalogue.

The Librarian feels it his duty to refer in this connection to the large number of unbound volumes which cannot be bound under the agreement made with Columbia College. At an approximate estimate there are not less than 800 volumes which need binding; and some provision for the expense of this work should be made in the near future. Unbound books in a public library rapidly suffer deterioration, even when used, as in the case of our library, as mere works of reference.

By appointment of the Council, the Corresponding Secretary and the Librarian were made a committee to cause certain back volumes and parts of the Academy's publications to be distributed in exchange to other societies and institutions. The greater part of the correspondence necessary in carrying out this task has fallen to the Corresponding Secretary; the Librarian has personally superintended the formation of packages, and a large amount of surplus material has thus been disposed of to good advantage. The remaining volumes and parts have been carefully wrapped, labelled, and an exact list of them prepared, giving us an inventory of stock in hand. It will doubtless be necessary to reprint certain pages of Annals and Transactions in order to supply future demands.

N. L. BRITTON,
Librarian.

The chairman of the Publication Committee, PROF. D. S. MARTIN, made an informal verbal report.

The following resolution, offered by the secretary, was adopted :

Resolved, That the Council be hereby authorized to send circulars of information concerning the Academy, and invitations to join the same, to the members of the late Local Committee of the American Association for the Advancement of Science, and to other persons desirable as members.

The annual election of officers for the coming year was declared in order. The President appointed Mr. A. L. Ewing and Mr. John I. Northrop tellers. The result of the balloting was declared as follows :

President, J. S. NEWBERRY.
First Vice-President, O. P. HUBBARD.
Second Vice-President, W. P. TROWBRIDGE.
Corresponding Secretary, A. A. JULIEN.
Recording Secretary, H. L. FAIRCHILD.
Treasurer, HENRY DUDLEY.
Librarian, N. L. BRITTON.
Councillors, J. A. ALLEN, P. H. DUDLEY, A. R. LEEDS, D. S. MARTIN, J. J. STEVENSON, C. VAN BRUNT.
Curators, H. C. BOLTON, B. B. CHAMBERLIN, S. L. ELLIOTT, G. F. KUNZ, F. J. H. MERRILL.
Finance Committee, J. H. HINTON, *Chairman ;* S. B. BROWNELL, L. E. CHITTENDEN.

The PRESIDENT reviewed the history and work of the Society. In comparing the present state with the past, he now found the Society in a more prosperous condition than at any time during the thirty-six years of his membership. It gave evidences of youthfulness, vitality, and activity which presaged well for the future.

MR. GEORGE F. KUNZ exhibited silver breast-ornaments and two pendent earrings of silver, found with Venetian glass beads and pottery, in a mound on Smidt's Key, at the mouth of the Caloosahatchie River, Florida. This locality is about one hundred and fifty miles southwest of the locality which supplied the gold ornaments mentioned at the meeting of November 8th, 1886.[1]

[1] See Transactions, Vol. VI., p. 40. [ED.]

Mr. Kunz stated that the supposed meteorite, exhibited at the Florida Sub-tropical Exposition, weighing two hundred pounds, and said to have fallen at Middleburg, Florida, was only a mass of limonite.

He also said that he had received a fragment of the Krasnoslobodsk meteoric stone, which fell September 12th, 1886, and was said to contain diamonds.

Dr. N. L. Britton spoke of the death of Prof. Asa Gray, and exhibited a large photographic portrait of him, recently made. The President also spoke of the deceased, and in pursuance of an adopted motion appointed Dr. N. L. Britton, Dr. E. S. F. Arnold and Prof. D. S. Martin as a Memorial Committee.

March 5, 1888.

Regular Business Meeting.

The President, Prof. J. S. Newberry, in the chair.

The audience completely filled the East Lecture Room of the Library Building, Columbia College.

The Report of the Council recommended as follows:

I. The payment of certain bills.

II. The payment of $100 to the Chairman of the Publication Committee.

III. The acceptance of the resignation of Rev. G. F. Krotel.

IV. The establishment of a Special Section of Mineralogy.

The recommendations were severally adopted.

The second lecture of the Popular Lecture Course was delivered by Mr. P. H. Dudley, C.E.:

THE PANAMA RAILROAD AND THE INTEROCEANIC CANAL NOW UNDER CONSTRUCTION.

(Illustrated with lantern views.)

March 12, 1888.

No meeting held, on account of the severe storm.

March 19, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Forty persons present.

Some Indian stone-implements from Mansfield, Penn., sent by MR. ANDREW SHERWOOD in illustration of his communication, read February 6th, 1888, were exhibited. These were flattened cobbles with small artificial depressions on the opposite flat sides.

MR. ARTHUR HOLLICK said these were examples of the prehistoric implements known among archæologists as "hammerstones;" and he showed similar worked cobbles which he had found in the shell-mounds of Staten Island. These were of sandstone, softer in material than those from Mansfield, and not as good in workmanship. He thought they were used for cracking oysters.

The first "hammerstones" from Staten Island were found in February, 1884, and were described in the *Proceedings of the Natural Science Association of Staten Island* for May 10th, 1884. Since that date he had found many in the same locality; and other places had also furnished them, for example, Keyport and Amboy, N. J., and Glen Cove, L. I. They are of different materials, including quartzite. Some are double-pitted on each side, some single-pitted, some only rough-pecked, while others are smooth or show only the natural inequality of the broad sides. But they all have battered edges, and to such a degree in some as to indicate harder usage than crushing mollusks.

The specimens from Staten Island are mostly in the cabinet of the *Natural Science Association of Staten Island.* A number may be seen in the *American Museum of Natural History.* Figures are given in an article by Charles Rau, in the *American Naturalist,* Vol. VII., entitled "Indian Netsinkers and

Hammerstones;" also in Dr. C. C. Abbott's "Primitive Industry," chap. XXIX., "Hand-hammers and Rubbing Stones," and in Evans's "Ancient Stone Implements of Great Britain," pp. 213–221. References to these objects are frequent.

PRESIDENT NEWBERRY remarked that these cobbles were doubtless employed in a variety of ways, and served the general purpose of hammers.

The SECRETARY read a letter from Messrs. J. W. Hulke and W. Topley, General Secretaries of the *International Geological Congress*, to be held in London, in September, 1888, cordially inviting the members of the Academy to participate in the meeting and become members of the Congress.

PRESIDENT NEWBERRY, speaking as a member of the American Committee, expressed his gratification with the character of the invitation, and the broad liberal spirit shown by the officers of the Congress, and hoped that every geologist in the Academy would join the Congress.

The following resolutions were reported by the committee appointed to formulate the sentiments of the ACADEMY regarding the death of

Asa Gray.

Whereas, It has pleased the Almighty to remove at a ripe old age our revered friend and Honorary Member, as well as former efficient officer of this Academy, PROFESSOR ASA GRAY, be it therefore,

Resolved, That we deplore in his death the loss of one of Science's brightest ornaments, whose indomitable energy, unceasing activity, and numerous valuable publications, placed him at the head of workers in that branch of Natural History to which he addressed himself with such untiring zeal, devotion, and success.

Resolved, That eminent as he was as a naturalist, he was no less conspicuous in the possession of those many qualities which adorn the character of the Christian gentleman. His kindly nature and warm geniality were manifested to all who came in contact with him, and will enshrine him in the hearts and memories of all who enjoyed his nearer personal aquaintance.

Resolved, That a copy of these resolutions be forwarded to her who has been his constant companion during the greater

part of his useful life, with the sympathy of this Academy in her affliction.

N. L. BRITTON.
D. S. MARTIN.
E. S. F. ARNOLD.

The resolutions were unanimously adopted.

DR. N. L. BRITTON exhibited a block of hornblende granyte, (quartz-syenyte) from the Powerville quarries, Morris Co., N. J., of great strength and durability, with no apparent bedding, and lying at the base of the Archæan series and characteristic of the class of rocks which he had designated the Massive Group.[1] It is a very tough rock of high specific gravity and dark color, owing to the large amount of hornblende, and has recently been employed in the construction of a large mansion at Morristown. The quarry is situated towards the southern end of an area of similar massive rocks underlying several square miles of Morris County, to the north and east of Boonton. As is the case in other areas of this group, the rock varies greatly in the percentage of hornblende contained, and in other parts of the same area varies toward granulyte, in which there is none of that mineral. Evidence of original stratification is found in the rocks of this massive group in the lamination and parallel arrangement of the minerals; and very rarely, and at very wide intervals, indistinct bedding planes have been detected. While there is no proof that they have had an eruptive origin, it is very evident that the forces of metamorphism to which they have been subjected have completely altered their structure. They have never been observed in the form of dykes.

The PRESIDENT spoke of the character and supposed origin of these basal rocks.

MR. W. E. HIDDEN announced the finding, by Mr. William Niven, in a pegmatyte dyke near 155th street and Eleventh avenue, of three mineral species new to the island. These are iolite, pinite, and xenotime. The latter is of unusual perfection.

Mr. Hidden also stated that he had received the past week, from North Carolina, zircon to the amount of six and one-half

[1] See Annual Report State Geologist of New Jersey, 1886, p. 77.

tons. This is employed in the manufacture of the Welsbach incandescent gaslight.

Prof. W. P. Trowbridge read a paper, deferred from the previous Monday,

ON THE QUESTION OF RIPARIAN RIGHTS, AS APPLIED TO COMPENSATION FOR WATER-POWER IMPAIRED OR DESTROYED, WHEN THE WATER OF A STREAM IS TAKEN FOR PUBLIC USE.

The subject was discussed by the President, Mr. W. P. Butler, Mr. L. E. Crittenden, and Mr. George G. DeWitt.

March 26, 1888.

Stated Meeting.

The President, Prof. J. S. Newberry, in the chair.

Eleven persons present, in a heavy storm.

The President announced the death of Dr. J. B. Holder, and spoke in praise of his character and work. In pursuance of an adopted motion, he appointed as a committee to draft resolutions expressing the sentiments of the Academy upon the loss of the deceased member, Prof. J. A. Allen, Dr. H. C. Bolton, Prof. D. S. Martin.

Remarks were made by several members upon the death of the eminent chemist, James Curtis Booth, of Philadelphia, eulogizing his character and work, as an accomplished man of science, and a gentleman of broad intellectual culture, and most attractive personal qualities.

The Treasurer made an informal verbal report upon the condition of the finances.

A letter from Dr. Robert H. Lamborn, written to the President from Rome, Italy, was read by the Secretary. It referred to recent archæological discoveries in that city.

April 2, 1888.

REGULAR BUSINESS MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Fifty-seven persons present.

The Report of the COUNCIL recommended as follows :

I. The acceptance of the resignations of W. H. Rudkin and J. Van Schaick.

II. The election of the following nominees:

For Resident Members:

FRANZ BOAS, M.D.,
THOMAS A. EDISON,
ANDREW J. RICKOFF,
B. A. WATSON.

For Corresponding Members:

Rev. Thomas Morong, Ashland, Mass.
T. Millard Reade, Liverpool, Eng.

For Honorary Member:

Prof. Dr. G. Meneghini, Pisa, Italy.

III. and IV. The payment of certain bills.

V. That the proposition of the N. Y. Mineralogical Club for union with the Academy be accepted, with the following conditions: The Club to retain its name and independence, and to meet with the Mineralogical Section of the Academy, and there to present its matter desirable for publication. The Academy to publish the communications of the Club, giving due credit to the Club in its publications and on the announcement cards.

The recommendations were severally adopted, and the candidates elected by formal ballot.

MR. B. B. CHAMBERLIN exhibited a white beryl, from a vein of decomposing granite, in gneiss, on First Avenue above 42d street. From the same vein were obtained the largest orthoclase crystals yet found on New York Island, some of them being four by six inches.

PROF. D. S. MARTIN, Chairman of the Publication Com-

mittee, reported the publication of numbers 3 and 4, of Volume IV., of the Annals.

Upon motion of the Secretary, item IV. of the Council Report, presented March 5th, 1888, was adopted.

It was moved and voted that the Secretary be authorized to issue a call for a meeting of the members of the Academy, who are interested in mineralogy, for the purpose of organizing the Mineralogical Section.

Dr. Charles B. Warring read a paper on

GENESIS I. AND ITS CRITICS.

The last word from the standpoint of scientific criticism was spoken by Prof. Huxley in his paper in reply to Mr. Gladstone, entitled "The Interpreters of Genesis and Science," published a short time ago in the *Nineteenth Century*. He there declares that, after making all possible allowance for the figurative use of language, one fact stands out clearly—the story of creation, in the light of geology, is all wrong as to the order of life upon our globe. He says in the most emphatic manner, as if it admitted of neither doubt nor dispute, that Moses, or whoever wrote the account, teaches that "the animal species which compose the water population, the air population, and the land population, respectively, originated during four distinct and successive periods of time, and only during those periods."

Prof. Huxley says nothing about vegetation in his paper, because Mr. Gladstone did not speak of it; but as it is logically included, and indeed is necessary to make the statement complete, I shall include this also. Putting it all into slightly different words, to bring out more forcibly what appears to be the Professor's meaning, he charges Moses with teaching that there was no vegetation before fruit trees, no animals before "whales," no flying creatures before birds, no land animals before cattle.

And this, Prof. Huxley declares, is the "central idea" of the creation narrative "by which it must stand or fall." The thought arises: If an error in the order is so fatal, will he admit the opposite, if the order is free from error?

We admit that it is not true that there was no vegetation before fruit trees. There were plants long before that, animals long before whales, flying creatures long before birds, and land animals long before cattle. But does Genesis teach what Prof. Huxley charges? This is the vital question, and Prof. Huxley

ignores it. We can get no help from him in answering it. He says Genesis so teaches, but offers no proof. We must look to the account itself. Glosses and commentaries cannot take its place, nor can they so attach themselves to it as to make it responsible for their errors. The story itself is the best possible and only authoritative witness as to what it teaches. To that, then, I appeal.

I think no one—certainly no scientist—will object when I say that, in the study of this account, the meaning of words ought not to be forced, nor the order changed; and that no one has a right to put into the story what is not there, nor to leave anything out of it. Nor can any opponent justly find fault, if we assume that this chapter means just what it says. I shall, therefore, consider grass, herbs, and fruit-trees as meaning what everybody would understand by these words elsewhere. And, since they are placed together by the writer, in the same division of the creative account, I shall treat them as intended to refer to one synchronous flora, one horizon, as geologists say. In like manner, I take the water creatures of the fifth period to be the marine fauna of one special horizon, and so also of the animals of the sixth period. In other words, we have here three distinct and successive geological horizons characterized by the presence of these organisms.

In briefest form, then, I take as my rules of exegesis:

1st. The story means what it says.

2d. It is not responsible for what it does not say.

3d. We may not add to it.

4th. Silence neither affirms nor denies.

Professor Huxley will surely welcome such an exegesis, since he has repeatedly lashed the "reconcilers of Genesis and Science" for their readiness to change and twist the meaning of words to meet the supposed demands of science. See his vigorous castigation of these unfortunate gentlemen in the paper under consideration; see also his first New York lecture.

These rules rigidly adhered to will, if I am not mistaken, lead to results surprising for their novelty, and even more surprising for their relation to truths which have been regarded as peculiarly within the domain of science.

I propose, then, to treat this first chapter, say to the end of the twenty-seventh verse, as literal history. The reader will bear in mind that I am now speaking solely of the creative account in the first chapter, and not of the Bible in general. That is composed of prose and poetry, ranging from the genealogies in Chronicles to the visions of the Apocalypse, and each part must be treated according to its own character.

If Professor Huxley's "central idea" is found anywhere in

this chapter, it must be in some part of verses 11 to 25. In verses 11 and 12 we read that, at God's command, "the earth brought forth grass, herbs, and fruit trees." In verse 21, after these, we read that God "created great whales and other living creatures which the waters brought forth abundantly, and fowl to fly in the firmament of heaven." Yet later we read in verse 25, "God made cattle, beasts," and other living land animals.

That is all as to the order of life. It does not say that no plants existed before fruit-trees, no animals before "whales" and fowls, no land animals before cattle. If the account is responsible only for what it says, then it has no responsibility for Professor Huxley's "central idea," and can neither stand or fall by it.

Moses (or whoever wrote the account) speaks of certain important matters, and as to all else is silent. But Professor Huxley fills the gap with what he supposes Moses would have said—but did not—and then exclaims, how impossible that this account is inspired! Four distinct and vitally important errors of fact in three brief sentences! Errors indeed, but not one of them in the story itself. It may be said, however, if these errors are not actually in the narrative, they are what the writer must have meant. In other words, he intended to go wrong, but somehow was prevented.

It is not necessary to consider what was intended. We have to do only with what is written, and keep clear of that "flexibility" which is so obnoxious to our critic.

After a most careful examination of the words of Moses, we are, as it seems to me, justified in the conclusion that what Professor Huxley regards as "the central idea by which the account must stand or fall," has no place in it, but is an interpolation which he has too readily accepted, a figure of straw which his logical hammer has demolished.

What, then, is the true "central idea" of the story?

It is God's creatorship of all things.

No other cosmogony has risen to that height. The Chaldean, from which it is the fashion to say this account was taken, says that heaven, earth, and sea preceded the gods. The "first tablet" declares that "at this time" (when the story begins) "the great gods were not made any one of them."

In Genesis, God's creatorship is clearly set forth from first to last. In the beginning He created the heavens and the earth, and in every stage it is God that does what is done.

If Genesis does not teach what Professor Huxley says it does, it may be asked, what may we learn from it as to the grand procession of life?

First, then, it says nothing about the first plants and animals.

Those of which it speaks belong exclusively to the end of the long series of "populations" which have inhabited the earth, leaving millions of years without mention. That the writer intended to refer to present living species is evident, not only because the terms used apply to existing forms, and not to the first ones, but because he represents God as giving Adam dominion over the animals which had just been made, and which, in order to be under Adam's sway, must have been contemporaneous with him.

Secondly, the account places the appearance of the plants of which he speaks before present water creatures and fowl, and these before present land animals.

Is this order correct? Did grass, herbs, and fruit-trees appear before present water animals and present fowl?

Count de Saporta is good authority. He says in "Le Monde des Plantes," page 380:

"The vegetable kingdom acquired its characteristic traits long before the animal kingdom had completed its own; so that probably even before the end of the Tertiary, the principal groups, and even the genera of the plants which compose the immense majority of our actual floræ, were established in the limits which they still occupy."

It is quite probable that new varieties and perhaps new species have appeared since the Tertiary, but there seems to be substantial identity between the vegetation at the close of the Pliocene, and that of to-day.[1]

It seems, therefore, that the work of the latter part of the third Mosaic period occurred in what geologists call the Tertiary.

The present vertebrate animals of the water and air come later, for, according to Professor Dana (page 518, "Man. Geol.," 3d ed.), no fish, reptile, bird, or mammal reaches back to the Tertiary, or, in his own words, "all the fishes, reptiles, birds, and mammals of the Tertiary are extinct." Whether Professor Dana is justified in so broad an assertion may be a question, but in a general sense it is true. Living species of "whales" and many other water creatures and fowl came,

[1] If "desheh" means only the tender shoots of the herbs and fruit-trees, as they broke through the ground, and not grass, then we might place the Mosaic flora in the Cretaceous, for then there were for the first time in the earth's history, as Le Conte says (and every other geologist for that matter), "angiosperms both dicotyls and palms;" or, in the exquisitely fit language of Genesis, "the tree bearing fruit, whose seed is inside of it."

But for many reasons it is most probable that "desheh" means what we call grass, and, if so, then the epoch must have been in the Tertiary, probably at the close, when there were living species of trees, etc.

therefore, according to geology, after the plants of to-day; and, as they are the fauna named by Moses, it follows that the work of the fifth Genesis period was contemporaneous with the Quaternary, for in this geological period are found great whales and other water vertebrates, and fowl, and of these far the larger portion are still living, for "no extinct species of fishes, amphibians, or reptiles" of that period have been found. (Nicholson's "Life History of the Earth," page 345.) Some few kinds of birds then living, as the moas and some other wingless species, are now extinct, but they became so in very recent times, long after Adam, and perhaps within one or two centuries.

There was, it was true, at the same epoch an abundant mammalian fauna, but it was not composed of species now living, for, according to Dana, page 563, "Geol.," "the mammals of the Quaternary are nearly all extinct." Le Conte, in his "Geology," page 569, speaking of the mammals of the latter part of the geological record, says, in substance, that the mammals of the Miocene are all extinct, that after them came a new set, also extinct, after them another, now extinct; then, in the Quaternary, another which also has disappeared; and, lastly, came present species, to wit, the living mammals, the cattle and beasts of to-day.

It would seem that, unless these and other distinguished geologists are greatly in the wrong, the fossils attest the correctness of the Mosaic order. Even if it is true—a question for others to decide—that some present mammals came down even from the Tertiary, they are few in number, and do not affect the conclusion that the present land animals, as a whole, came last of all living forms.

Nor does the fact that there was some overlapping, some species of mollusks and others coming down from earlier times, militate against the accuracy of the story if we take it just as it says, neither adding to it nor taking from it, for it makes no claim to universality. It merely says that, at a certain time, the earth or the water was to do certain things named, and we know that it did then. The fact that other things had been done before does not affect the truthfulness of the account.

There is, however, in the story itself a curious implied recognition of other living creatures besides those named in the fiats. It is in the working out of this central idea—God's creatorship—of which I have spoken. I have said that it pervades every part of the narrative, but in the twenty-first and twenty-fifth verses there is a broadening of the record which, in the light of geology, is very suggestive. In verse 20 we read: Let the waters bring forth certain creatures, not all, or every. But in the next

verse the statement widens, and God is said to have created "every living creature," etc., those then coming into existence and those surviving from an earlier epoch.

In the same way, we note that, in the sixth period, God commands the earth to bring forth certain creatures—not all or every creature—but in the next verse it says: God made those, and also "every moving creature." Whether I am right or wrong as to the purpose and value of that word "every," the fact remains that Genesis does not deny the existence of floras and faunas earlier than those which it mentions.

By chance, or otherwise, the variation in the wording of these verses makes them in accord with the story of geology.

There are other matters in regard to which, it is said, that science proves Genesis in the wrong. Each has been a point of attack on the ground that here Genesis contradicts known physical truth. I pass over the science which was sure that Genesis was not from God, because it speaks of light as existing before the sun, an argument which will never again be advanced. Nor need we spend any time upon those, if such there yet be, who reject this account because they think it teaches that the heavenly bodies are held up by some kind of a firm crystalline dome, for this has been exploded by an examination of the Hebrew.

The principal questions yet in dispute are the "days," the work of the fourth period, man's creation, and the teaching of this chapter in relation to evolution.

Reversing the order of these questions, I would say in reference to evolution that Genesis states facts, but presents no theories, and offers no explanations. As to the how and the why, it is silent, except to attribute everything to God acting through nature. The earth brings forth the plants; the waters swarm with living creatures, and the air with fowl; the land produces its creatures, and the only explanation offered is that God made them all. Evolution, or production from antecedent forms, may or may not have been God's method, Moses saying nothing about it, but silence is not denial.

There is, it is true, an appearance of abruptness, as if the plants or animals came suddenly into being, a thing quite in opposition to Mr. Darwin's belief in gradual evolution. One cannot but admire the flexibility of science (to borrow Professor Huxley's fling at Genesis in his New York lecture), when now he reads in Professor Huxley's lay sermons that Mr. Darwin unnecessarily hampered himself by insisting upon gradual evolution. The evidence of geology is overwhelming (evolutionists admit it), that from causes which science does not understand, there were times of exceptionally rapid development of

higher forms. Prof. Le Conte in his "Evolution," page 248, says: "Such changes are usually more or less paroxysmal, far more rapid at some times than at others." The abruptness is quite as marked in the strata as in Genesis.

As to man, the time has not yet come to dogmatize from the scientific standpoint as to the mode or date of his coming into existence. Adam, according to Genesis, was formed in the same epoch with present cattle, beasts, and other creatures. Whether human beings preceded Adam, no hint is given, but silence is not denial. In later chapters there are two or three statements which the existence of pre-Adamic men would render more easy to understand. Scientists as yet are able to give very little information on the subject. It seems the part of wisdom to wait until we have more knowledge in regard to man's early history.

As to the work of the fourth period, it is claimed that Moses teaches that the "great lights" were made and placed in the heavens after there had been grass and fruit trees; the sun after vegetation!

The same close adherence to the letter of the account will, I think, carry it safely by this difficulty. Read as literally as possible, Moses says: Let the lights in the firmament (expanse) of heaven be for to divide (a Hebraism for, let the lights in the firmament of heaven divide) between the day and the night, and let them be for signs and for seasons, for days and for years. And then he says: And it was so, it was done.

This seems to settle the matter, for if the two great lights had already obeyed the command, how could they be called into existence afterwards? Hence the next verse does not teach that they were made then; it is merely one more claim to creatorship. It is a parenthetical statement that God, to whom their obedience had just been recorded, was their Creator. He made them, placed them on high, assigned them their duties in reference to our planet; and he made the stars also.

Its place in the narrative, between modern plants and modern animals, seems to correspond most nearly to that of the Glacial epoch. When scientists have told us what occurred during this period and at what time the axis of the earth became inclined twenty-three and one-half degrees, we shall be in a condition to compare what they say with what Moses has put on record. The theme is a tempting one, but lies beyond the limits of this paper.

All that I would now insist upon is, that Genesis does not teach that the sun and moon were made so late in the world's history.

No part of this account has given rise to so much controversy as the word rendered "day." It is claimed that, according to

Moses, the earth and its contents were made in the short space of six consecutive days, and that, in consequence of so great an error, we must refuse to admit the divine origin of the story.

The same strict adherence to every verbal detail, as strict as that which astronomers give to the photographs which they take of celestial phenomena, will I think carry the account safely by this difficulty.

Suppose then that one was reading the story for the first time, and with no belief or theory about it. In short, suppose he had never heard of it, or of the controversies to which it has given rise. He would note in the first four verses a statement that certain important things were done, but no hint as to the time occupied in doing them. He would note after this an interruption in the current of the narrative, a sort of dam thrown across the stream. Just as the fourth of July, 1776, stretches across the stream of American history, and marks the end of colonial life, and the beginning of national, so the "first day," the first complete day and night, marks the end of the self-luminous condition and the beginning of the non-luminous or true planetary state. But the story does not say that anything was done on the day.

In verses 6, 7 and 8, he would read of the condensation and descent of the waters which in superheated vapor had covered the earth to the depth of many hundred miles, and the announcement of its completion in the words, "And it was done." Then he would note a second day clause, which interrupts the current of the story, and divides that stage from the next, but on which it is not said that anything was done. After this he would read of another long stretch of work, and again find the story interrupted, the past marked off and divided from that which was about to follow.

Going through the narrative, he would find three more interruptions, each following and preceding a stage of work. So far as this account says, no work was done on any one of these six days, but all was done in the interval between them, of whose length no intimation is given. Tried by the letter of the text, the charge that Moses says the earth was created in so brief a period must be dismissed. In fact, the real ground of the charge is not anything in Genesis, but it is the wording of the fourth commandment.

I am well aware that many regard "day" as used in this story figuratively for a period of indefinite length. But any varying from the intensely literal character of this chapter seems out of harmony with its other statements, while the use of day to denote a long period would be in harmony with the commandments; for their most marked characteristic, rhetori-

cally speaking, is that figure which is styled synecdoche, or putting a part for a whole. Theft stands for all crimes against property; murder, for all against the person; adultery, for all against purity; and so through the list; everywhere the last of a class is put for the whole class. So I take it, the days of Genesis, each the last day of a long period, are used in the commandment for the whole periods.

I have spoken only of the negative results arising from an exegesis based upon the rigid rules laid down in the beginning of this investigation. Its positive results are no less important, and are worthy the serious attention of its critics.

The following statements are clearly set forth in the first four verses.

The earth had a beginning.

It was without form[1] and void.

Before motion, it was enveloped in darkness.

Motion was imparted by the same first cause that created the heavens and the earth.

The earth then was not solid, but a mobile flowing substance (*mayim*, that which flows).

The first visible effect of motion was the production of light.

Light became good (*i. e.*, such as that of the sun), before there was a separation between light and darkness, *i. e.*, before day and night began.

To see the value of these statements, one needs to reverse them, or change their order, thus:

"The earth never had a beginning;" then, all that we have been taught about the sun's loss of energy, or about the effect of tidal friction, or Prof. Tait's degradation of energy, is an error.

"The earth never was without form and void, never was a mobile, easily flowing substance;" then, what scientists have taught us about the earth's once gaseous condition is an error.

"Darkness did not cover the deep, before motion was imparted;" then, the corpuscular and the undulatory theory of light are both errors, physical impossibilities.

"Light did not become good light till after day and night began."

Then, what the spectroscope has told us about the poor, three-banded spectrum of nebulous matter, gradually improving as the gaseous substances approach a liquid or solid form, till it becomes good light, like that of the sun, all this is an error.

The importance of these statements and their order cannot well be overestimated.

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[1] This is not a happy translation of "tohu." It is "vanity, almost nothingness," a term peculiarly applicable to nebulous matter, a thousand times thinner than air.

We pass on to the next stage.

At first, after the earth had cooled so far that day and night began their alternation, geology tells us that it was enveloped in aqueous vapors of enormous depth, and that the next step in fitting it for life—vegetable or animal—was to thin out these vapors, till, as now, there was a clear, open expanse separating the waters above it from those below it.

The next step recorded in Genesis is wonderfully like this: "God made an expanse—most literally, a thinning out with violence and noise—in the midst of the waters."

Geology tells us, too, that the atmosphere, after this dispersion of the dense clouds, was loaded with poisonous gases. The atmosphere was not good, and if the reader will turn to Genesis, he will see that the verdict good, which is found in the five other accounts, is omitted from this—an omission wholly inexplicable till now.

Geology says that at first the land was under water, and so does Genesis. They agree, too, in saying that the waters are gathered into one place, for the oceans are parts of one great basin.

Geology tells us that the next work was to so purify the waters and to so enlarge and enrich the land that they became good for modern types of plants and animals; that, after they had become thus fitted, modern vegetation appeared, but not as yet present living species of animals.

This story of geology reads like a paraphrase of Genesis. There we are told the land appeared, and it and the waters were pronounced good, and after that, there were fruit-trees and grasses.

Geology tells of a strange climatic change after modern plants had appeared. It tells also of "zoneless climates," climates apparently without change of seasons, of uniformity of environment, such that, till late in the world's history, the same plants grew indifferently in the highest and lowest latitudes. Since light is one of the most important of the forces affecting plant life, it would seem that, after the Tertiary, the axis of the earth, from some cause unknown to science, passed from a nearly perpendicular position to its present obliquity.

It is remarkable that Genesis places next after present plants a change of some kind introducing seasons, affecting the days, and making the year an easily recognized measure of time, and says nothing of weeks or months—an omission entirely in accordance with the fact that an increase in the obliquity of the earth's axis would not affect them.

After this transaction, whatever it was, came present water animals and fowl, and, yet later, present land animals.

So far as I can judge, this brief and incomplete study of the first chapter of Genesis shows that our rules of exegesis merely formulate its real character, the most literal history imaginable. It is wonderful how objections vanish, and agreements become visible, agreements with the science of to-day, not that of the times when the story was written. There may be conflict with certain theories of modern date, but nothing is more changeable than inchoate scientific theories. In such cases, the lesson of the past is: Wait.

A poet, believing in one God, creator of all, might, perhaps, have woven into a hymn of creation, most of the things in this story. He could have spoken of land and water, and of plants and animals, of the heavens, of the expanse, of a beginning when light was not, and there was no day, and possibly he might have dreamed of an earth once covered with water, of an earth without form and void, of light and darkness—but could he have placed them each in its true order?

A careful analysis shows more than thirty points where this story touches modern science. Unlike the statements in the Chaldean Genesis, they are not platitudes, or trifles, or absolute absurdities, but all are important, and the falsity of some, if it could be established, would be fatal to much of what we call science.

Somehow it has happened (?) that Moses and modern science have each placed these thirty or more points in the same order.

Could this have occurred by any human knowledge of the earth's history, or by chance?

I have made but a brief statement, a hint rather than a full development of the argument, yet I submit that even in this imperfect representation there is too much truth, too much accord with the order of science, to be answered by sneers at the flexibility of the Hebrew, or by assumption of errors which are the interpretations of commentators in their eagerness to make the story square with "science," or of scientific critics, in their desire to demolish an account which, if true, establishes the reality of a revelation and of miracles, for revelation is a miracle.

A brief resumé of correspondences between Genesis and Science.

Genesis says:	*Science says*
1. In the beginning God created the heavens and the earth and the earth was without form[1] and void.	Science admits a creator, claims a once nebulous condition when the earth was literally formless[1] and void.

[1] "*Tohu*" admits of several renderings, each of them more or less applicable to nebulous matter. The best result is obtained by taking

2. And darkness was upon the face of the deep.

And the spirit of God moved upon the face of the waters (*mayhim*, that which flows, *i. e.*, fluid).

3. And there was light.

4. And God saw that it was good, and (after that) God divided between the light and the darkness.

5. The light he called day and the darkness he called night.

7. And God made an expanse in the midst of the waters, and let it divide the waters below it from those above it.

8. And God called the expanse heaven.

It was not pronounced good.

9. Let the waters be gathered unto one place and let the dry land appear.

10. And God saw that it was good (*i. e.*, done or completed).

12. And the earth brought forth grass, the herb yielding seed, and the fruit-tree yielding fruit wherein is its seed.

And God saw it was good.

Both the above are put into one stage of development, the third.

14. And God said: Let the lights in the firmament of heaven (so in the Hebrew) divide between the day and night, and let them be for signs and for seasons and for days and years. And it was so.

A beginning implies a time before motion, and of course no light.

Science has no explanation of the cause of motion but God's will.

The earth at first was fluid.

Light followed motion.

The spectroscope tells us that the poor light of nebulous matters becomes good light, such as that of the sun, while the body is still self-luminous. And only after the light is thus perfected comes an opaque crust and day and night.

After the crust had become opaque it was still so hot that a large part of the water was in the air as clouds and vapors, and the next step in world-making was to get rid of them.

The end of the process was indicated by such atmospheric transparency that sun, moon, and stars were visible.

The early atmosphere was not good, for it was loaded with poisonous gases.

When the deposition of the waters was completed, they covered the globe as a rind covers an orange. But the continents lay just below the surface (Dana) and soon began to emerge.

The completion of the continents was effected in the Pliocene. This fixes the date for the event in Genesis.

In the Pliocene the earth brought forth the flora of to-day, including grass, herbs, and fruit-trees of living kinds.

No farther advancement has been made in the vegetable world since the Pliocene.

Both completions occurred in one period—the Pliocene.

At some time the days and nights began to be unequal, and seasons were introduced. Astronomers cannot tell when nor how the axis became inclined. The evidence of geology is that in the earlier ages there were the same plants from

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each in turn and so getting a sort of "composite picture." Nothing can be more fitting to what is believed to have been the earth's earliest condition.

	the poles to the equator, and it teaches of like environments in high and low latitudes, of which one of the most important is light. Such conditions require an axis nearly perpendicular. (The reader will please not to consider this even an attempt to discuss this period. Nothing can be done within the necessary limits of this paper.)
21. And God created great whales, and every moving creature which the waters brought forth abundantly, and every winged fowl after its kind. And God saw it was good.	After the glacial epoch and, *à fortiori*, after the Pliocene, present water vertebrates appeared for the first time, and present fowl.
	No further advance has been made in the genera, and scarcely any in the species.
25. And God made the cattle, beasts, and everything that creepeth on the earth. And God saw that it was good.	In most recent times and after the last-named animals, the living mammals of to-day appeared. This was final. No new mammals have been added. It ended the long preparation for man.
27. And God made man (Adam in the Hebrew) in his own image.	Perhaps there were other races earlier, but the race of Adam, the progenitor of the people about whom the Bible is mainly written, came into being at this end of the creation work.

It has been said that no philosophical divisions of the "creation" into six periods can be made. The following, which is merely the Mosaic division, seems to meet the requirements.

1. The nebulous or embryonic stage, ending in an opaque earth, with days and nights.

2. The pluvial stage, ending in a world covered with water.

3. The preparatory stage, reaching from somewhere in the Archæan to the latter part of the Tertiary, including continental development and the finishing of vegetation.

4. The fourth stage, in which the sun and moon become time measures, unequal days and nights and seasons were introduced.

5. The fifth stage is the final stage in the development of water creatures and birds.

6. The sixth stage includes the production of living mammals.

The most remarkable things about the account are its freedom from monstrosities, the agreement of its order with that of the world's history, and the manner in which it meets the requirements of what a revelation should be, as they are set forth by Dr. Draper.

"Considering the asserted origin of this book,[1] indirectly from God Himself, we might justly expect that it would bear to be tried by any standard that man can apply, and vindicate its truth and excellence in the ordeal of human criticism. . . . As years pass on, and human science becomes more exact, more comprehensive, its conclusions must be found in unison therewith. When occasion arises, it should furnish us at least the foreshadowing of the great truths discovered by astronomy and geology, not offering for them the wild fictions of earlier ages, the inventions of the infancy of man."—*Dr. Draper in The Intellectual Development of Europe.*

Thus much for the positive side, now for the negative.

Genesis does not say that world was made 6,000 years ago.

It does not say that anything was done on any one of the "days."

It does not speak of the first plants or water animals, or birds, nor of the first land animals.

It does not say how they were made.

It does not say that the earth is the largest body in the universe.

It does not say that it is larger than the sun.

It does not say that the stars are less than the sun or moon.

It does not say that all plant life began at one day—nor does it say that of either aquatic or land animals, or of birds.

Dr. Warring then read a paper on

MIRACLE, LAW, AND EVOLUTION.

I. *Miracles and Law.*

I do not propose to discuss the reality of the miracles recorded in the Bible. Those who deny their possibility, as well as many who believe in them, look upon miracles as generically different from those occurrences which are said to take place in obedience to the laws of nature. There certainly is a difference. I propose to inquire what it is. Evidently it is not in the degree of power required; for raising the dead is a less thing than the birth and growth of an individual. It is less to set in motion a watch that has stopped, than to make one. Causing the widow's oil and meal to increase was a small matter in comparison with providing daily food for the millions that cover the earth.

Nor are miracles intrinsically more wonderful than those things which we regard as the effect of law. Nothing is more common, or less excites our surprise than the working of the

[1] Dr. Draper is speaking of the Koran, but his words are better than he knew.

law of gravitation; yet, what is more wonderful than a force which, according to Laplace, travels more than fifty million times faster than light, itself moving with the inconceivable velocity of nearly two hundred thousand miles in a second?

Were to-night, in some far distant constellation, another sun called into existence, ages would pass before its light could reach our earth, but only a few seconds would elapse before the earth would feel its presence.

Nor is this velocity the only or the greatest cause for wonder. Another property of this force far surpasses that. I mean its ability to adjust itself with omniscient accuracy to every change in mass, or position, of bodies however widely separated.

The adjustment of position and movement of every member of our solar system, and, I may add, of the universe, to the mass, distance, and position of that new sun would at once begin and, in due time, complete itself with an exactness that is perfect, and which no human measurements can hope to equal. And since every atom is attracted by every other atom in the universe, it is a sober fact that the fall of a sparrow is registered in every star fifty millions of times sooner than light can speed its way across the abyss that separates them. Can any miracle be more wonderful than that?

We may extend the comparison as far as we please, and we shall find in all cases that miracles differ from what we regard as the effect of law, neither in the amount of power required nor in their intrinsic wonderfulness.

We must, therefore, seek for some other characteristic by which they may be distinguished. So far as I can see, this lies in the continuity of the one, and the absence of continuity of the other. In a world where no vegetation had ever existed, the production of an oak would be a miracle. To us it is merely the outworking of law, because it goes on continuously. The first plants and the first animals came into existence by a miracle. They continue to come into being, and now it is law. In every law the first of the series was a miracle, and, had we been present, would have excited our profound wonder. But often repeated, it ceases to excite surprise, yet the thing itself is unchanged.

The dead rising, the deaf hearing, the blind seeing, when commanded by Christ or in His name, were miraculous occurrences. But if this had continued, if every time a dead man was told in that name to rise, or a deaf man to hear, or a blind man to see, he had obeyed, no more surprise or wonder would be excited than now that men wake from sleep. It would be simply the way in which nature works.

So far, then, as I can see, the peculiarity of miracles lies in

their uniqueness. Each stands by itself. A miracle may be represented by a point; law by a line; successive points make a line. Miracles indefinitely repeated crystallize into law. In briefest phrase, law is continuous miracle. Those, therefore, err who rank miracles as higher or more divine than law; for as two are more than one, and four more than three, and a series greater than any one of its terms, so law is greater and intrinsically more wonderful than miracle. Neither admits of explanation other than the will of that First Cause which lies back of all.

II. *Miracles and Evolution.*

What, it may be asked, have these to do with each other? Are they not catch-words that represent the opposite poles of modern thought? I ask your patience and attention, and, when I have done, I hope it may be clear that they do have something to do with each other, and that, if they represent opposite poles of thought, they help to weld fragmentary truths into one consistent whole.

Christ is represented not only as a worker of miracles, but as the Creator, the informing spirit that produced all things which exist, or ever did exist.

Those who believe this, and that includes all who regard the New Testament as inspired, will, I think, agree with me when I say we may reasonably expect to obtain from the study of His methods, when performing His miracles, some light as to His course when acting in His capacity of creator. Just as when we find certain peculiarities of style or diction in one of an author's books, we expect to find them to some extent, at least, in all his works; so, if we find some peculiarity, some way of doing things that runs through all His miracles, it would be reasonable to look for it in His mode of doing His creative work. And I think we are safe in saying that of two theories as to how certain things were done, *e. g.*, how present animals came into the world, that which harmonizes best with His methods when working His miracles would be the most likely to be true.

A brief study of the accounts which we have, will suffice to show that, in Christ's miracles, natural means, laws, and powers go just as far as is possible for them, and then the supernatural comes in and does what they cannot do. When, for example, at the marriage in Cana, Christ would supply the lack of wine, there was the water, the jars, the servants, all in the usual way. He bade the servants fill the jars with water. They did that, and it was as far as natural means could go; then came in His power and added the components needed to make the water wine. This done, the supernatural ceased, the natural again came into opera-

tion, for it was the servants that drew out the wine and bore it to the governor of the feast.

Would He feed the hungry thousands? He commanded them to sit down, took the bread and fishes, broke them, and gave to the disciples to distribute. Thus far all was in accordance with law, and it was as far as law could go. At that moment, the divine power came in and did the one thing impossible for nature: it caused the bread and fishes to multiply.

Even here he kept as close to the natural method as was possible. Would we have an increase in our stock of food, we take wheat, and it produces its own kind, or barley, and it produces barley. In all cases by natural law, we take a portion of that of which we would have more, and it multiplies. So here. He would have more bread, he took that, and it produced its own kind. He would have more of the fishes, and the animal fabric grew under his hands, and from what he had, came more of the same kind. It was like producing like, in a strange, abnormal way, it is true, but no more inexplicable, in the last analysis, than is now what we call the natural process by which we get our food.

After the increase of the loaves and fishes, there was no further need of miracle, all else proceeded in the usual way. The multitude ate and were refreshed in the ordinary manner, and the disciples gathered up the fragments.

Would He supply tribute money for His disciples? He told them what they could have learned from no power in nature, viz., where to throw the line to catch the fish which had seized the glittering coin, as it sank in the water of the lake. Up to a certain point, all was natural, the hungry fish voraciously seizing the sinking coin, the line, the fisherman; the one thing needed to complete the transaction, the omniscience which notes the fall of a sparrow, was supplied by Christ. The disciples did the rest. They took the money and paid the tribute.

When He raised the dead child, He brought back life and health, but He commanded those present to give her food. She got life from Him, but strength she was to get in the ordinary way.

When He restored Lazarus to his sisters, he bade the Jews standing around roll the stone away from the tomb. Then they reached their limit. At this instant of absolute helplessness, when nature and man could do nothing, He interposed and gave life to the dead body, but it was the living Lazarus himself that walked out of the sepulchre, and it was those standing by who loosed him from the grave clothes. Christ's exercise of miraculous power, here also, was confined to the one thing law could not do, the restoration of life.

All the other miracles, so far as we can judge from the very brief record, are marked by the same characteristic.

Hence, I think, we may conclude that the divine method in miracle-working was to do only that which Nature, with her laws and powers, could not do, and then to let her do the rest. What was already in existence was invariably used, as far as it could be applied, and to this was added only that which was necessary to complete the transaction.

Hence it seems reasonable to infer that, in His work as Creator, He used whatever was nearest to His purpose, and exerted power above Nature only to do what she could not. As to the rest, He left it to the outworking of natural causes.

Now for the application.

The world of to-day contains many thousand species of plants and animals. There is indisputable evidence that the present is only the last of a long series of "populations," each differing from its immediate predecessor. Each antecedent population was of a lower grade than its successor, until at last we reach the dawn of life where only the lowest orders are found. Or, conversely, starting at the beginning of life, there were for millions of years radiates, articulates, and mollusks, but no vertebrates; then for other millions, there were water vertebrates, but none on the land; then for thousands of centuries, land vertebrates but no mammals, and for another long period, mammals, but none of existing kinds, and lastly those now living.

One example will suffice, although it reaches back but a little way, yet far enough for my present purpose.

Many thousand years ago, there lived an animal which geologists have named Orohippus, or the Mountain Horse. It was about the size of a very small Shetland pony, which in many respects it resembled. Still it was not a horse, for it had four little hoofs on each fore foot, and three on each of its hind ones. The genus lived many thousand years, each generation like its predecessor; but at last "from some cause unknown to science," a new animal, in fact a new genus, appeared, different in some respects from the Orohippus, and approximating somewhat more to the present horse, yet not a horse, for on each of its feet were three hoofs. The Mesohippus, for so geologists have named it, also kept on for many generations, producing at every birth only its own likeness. After a uniform course, for we know not how many thousands of years, there appeared another creature, the Miohippus, very much like its predecessor, but approaching more nearly to the horse. The middle hoof was larger, indicating a promise of an animal in which the two side hoofs should disappear. The Miohippus lived from generation to generation its uneventful life, one monotonous series of like

producing like, till at last another animal made its appearance still in the same line of progress; the side hoofs remained, but of diminished size, while the teeth became more like those of the horse.

This genus (Protohippus) ran its course, and then another (Pliohippus) came into existence with greater resemblance to the horse, for it had single hoofs, and teeth still more equine.

Next and last came the horse, the living servant of man.

It is not possible as yet to trace the pedigree of any other animal as satisfactorily as this; there is, however, sufficient evidence to induce the belief that there has been a similar process in all species.

The question is how to explain these facts. Scarce any one doubts that the first life came direct from the Creator. It is in regard to the successive populations that biologists differ. The fact of there having been such is beyond dispute. It is as to the manner of the successive genera coming into existence that there is question. Only two suppositions are conceivable. Either each species was made *de novo* by the Almighty, or it was born of some preceding creature of a different species. The former is the older theory, and claims to be in exclusive harmony with sacred writ. It teaches that God made, *e. g.*, the Mountain Horse, Orohippus, from earth, air, and water, and gave it life; that later, from more of the same raw materials, he made the Mesohippus; and yet later from more earth, air, and water, he made the Miohippus, and endowed it with life; that, after another long interval, once more from more earth, air, and water, God made the Protohippus, and so on down to the present horse. There was a succession of creations, but no genetic relation between them. This theory was devised when nothing was known of the life history of our globe, and when the plants and animals of Genesis were thought to be the first and only ones that ever existed.

The other theory also holds to the belief in a Creator. It, however, teaches that only the first kinds of plants and animals were made direct from inorganic material. It admits of special creation sufficiently to account for the first links in the chain of life, but claims that, from these, others of new and different kinds were produced at some subsequent time, and from them others, and so on down through many stages to the present. It holds that the law of like producing like was then as now the law, till time and environments were ready, perhaps after thousands of generations, and that then "some cause unknown to science," an agnostic euphemism for a more or less direct act of the Creator, so changed the factors in what may be called the

personal formula of the embryos,[1] that they grew up into animals of species till then unknown. Thus, for example, "some cause unknown to science" so changed the embryo in an Orohippus, that it was born a Mesohippus; and, after many thousand generations of the new species, like begetting like for all that time, the "cause unknown to science" so changed the embryo a second time that from the Mesohippus was born a Miohippus, as if now from a panther a lion should be born, and thus the process went on.

The first of these theories, the creation *de novo* for each new species, is as unlike the course of Christ in His miracles as possible. He employed what was already in existence and nearest to His purpose, and put forth the least possible amount of divine, or extra-natural, power that would suffice to adapt the same to his design. The production of new species by changes in preceding forms nearest related, appears to be in perfect harmony with His method.

Such derivation of new species from older species is the essence of evolution, and this whether the evolution was by imperceptible degrees as taught by Mr. Darwin, or at once, per *saltum*, a bound, as it were, at one birth, or at most, in a few successive births, from the old to the new. Such abrupt changes seem most in harmony with the teachings of the miracles. In these the thing to be done was done not imperceptibly, but at once.

So far as I can read the record of geology, its evidence also is in favor of abrupt changes. The links in the pedigree of the horse are well defined; there is not an imperceptible, long-continued transition from genus to genus. There was the Orohippus, and, after a time, suddenly the Mesohippus appears; again, there was generation after generation of the Mesohippus, and then, all at once, is found the Pliohippus, and so on.

In spite of an original and very strong bias the other way, biologists now admit the occurrence of sudden starts upward, jumps in the progress of development. Prof. Huxley, in his "Lay Sermons," page 297, says: "We believe that nature does make jumps now and then." May we not ask: Is there conclusive proof she ever does otherwise? He adds: "Mr. Darwin embarrassed himself with the aphorism which turns up so often in his pages, 'Natura non facit saltum.'"

Prof. Cope, "Origin of the Fittest," page 123, unwittingly illustrates the unwillingness of the biologist to give up the gradualism of Darwin, and the conclusiveness the other way of

[1] "The transition from type to type was done during fœtal life." Cope, *Origin of the Fittest*, page 276.

the geological record. He says: "The results of such successional (embryonic) metamorphoses are expressed in geological history by more or less abrupt transitions, rather than by uniformly gradual successions." It is difficult to avoid the belief that, but for theoretical reasons, biologists, in reference to new species, would almost adopt the motto, Natura semper facit saltum. Be this as it may, evolution gives us no aid in accounting for the changes. The survival of the fittest, however important in determining what varieties shall survive, gives no assistance in determining how and why the variations occurred. As Prof. Huxley well says: "What the hypothesis of evolution wants is a good theory of variation." At present it can be attributed to nothing more definite than "some cause unknown to science." Miracles are equally well explained in the same way.

The believer in the Bible will ask: "But does not this conflict with the story of creation in Genesis? If Genesis be true, is it possible that present species of animals are descended from older species, and back through many steps to the first stages of life upon our globe?" But wherein is the contradiction? Genesis says only that God made, or created, the various creatures named. As to how He did it, there is absolute silence, hence, as to the mode of bringing into existence, contradiction is impossible.

The chief interest most persons have in evolution pertains to man's origin. As to his higher part, the soul, few will be found to deny that it came direct from God.

The doubt is as to his body. Did God form it directly from the ground and atmosphere, moulding the mixture to his purpose, and then give it life? Or did He take, in embryo, or after birth, some animal nearest to his design, and enlarge its form, shorten the length of its arms, change its hand-like feet till fitted for man's upright position, and enlarge the capacity of the skull to fit it for the large brain which was to be the facile instrument of the soul, the go-between of the soul and the body? Whichever really was the mode of man's creation, there can be, I think, no doubt that the latter is most in harmony with Christ's methods when exercising His power in the miracles. And as for the question of dignity, surely matter which under the divine hand had been prepared and refined in all the infinitely delicate machinery of a living body, though that of a brute, was, to say the least, as worthy of man as that which had never since its creation received the divine touch, but had lain, raw and crude, beneath the feet of man's predecessors.

Then there is the creation of Eve. God undoubtedly might have made her as he did Adam. But in accordance with the law that runs through the miracles, it would seem probable that

God took material nearest fitted for His purpose, and in harmony with a method found all through nature, propagation by fission, caused from a part of the man a woman to grow. It seems to me that this was closer to nature's methods still in operation—like producing like—than such changes in another simian, as occurred when one changed to a human being, and became in the sense which we all understand, but shall never comprehend, a living soul.

It will seem strange to many that the study of the miracles of the Bible has led to the support of evolution, so strange, that I fear it may hinder their giving due weight to the argument. But, although some advocates of evolution may appear to desire to use this theory to shut the Creator out of His own world, it seems to me that species produced by modification of previous species show His hand as unmistakably, nay, I would say, show it more clearly than if moulded direct from earth, air, and water.

The subjects were discussed by MRS. VIRGINIA K. HASCALL, PROF. D. S. MARTIN, the PRESIDENT, and the author of the paper.

April 9, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Seventy-one persons present in the Geological Lecture Room, Columbia College.

A paper by LIEUT. THOMAS L. CASEY was read by title:—

ON SOME NEW NORTH AMERICAN RHYNCHOPHORA.

(Published in the Annals, Vol. IV.)

MR. GEORGE F. KUNZ exhibited a jadeite tablet from Honduras. It measures about six and one-half by four and one-half inches, and is one-half inch thick. One side is carved with a rude representation of a face, with pendents hanging from the ears. It is evidently Maya work, highly polished, and one of the finest jadeite relics known. The perforations indicate that it was worn as a breastplate.

Mr. Kunz suggested that the famous "Leyden plate" found in 1875, and the "Humboldt celt," obtained by Humboldt, in 1803, from Sr. Del Rio, and now in Berlin, were probably parts of one large celt, from which other pieces might also have been taken. The dark-brown color was probably produced by heat. There is no record of jadeite being found *in situ* on this continent, the only known locality being Burmah.

PRESIDENT NEWBERRY thought it not improbable that the jadeite found fashioned into ornaments at many localities in America and Europe, was of eastern origin. It seems to have been regarded as a substance of inestimable value, a badge of royalty, and to have passed from hand to hand for ages. Its occurrence in Mexico suggests communication between the Old and New Worlds, more probably by way of the East Indies.

Mr. Kunz also exhibited a new form of oligoclase, transparent and glass-like, from near Bakersville, N. C. It contains white, stellated inclusions, similar in form to those observed in the Ceylonese moonstone; but, while the latter are crystals, the former are merely hollow spaces. He also announced that he had identified spessartite garnet, from Amelia Court House, Amelia County, Va. In color hyacinth, light-brown and dark-brown.

PROF. J. S. NEWBERRY gave an address upon

THE PROGRESSIVE DEVELOPMENT OF THE MEANS OF ATTACK AND DEFENCE IN FISHES.

(Profusely illustrated with specimens and lantern views.)

April 16, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Thirty-two persons present.

MR. WILLIAM L. ELSEFFER presented the following:—

DATA RELATING TO THE MISSISSIPPI RIVER.

The river reached a lower stage during the low-water period of 1887 than for several years, excepting at New Orleans, where low-water stage was relatively and exceptionally high.

The Chief Signal Officer U. S. A. has furnished me with the following data, viz.:

At Vicksburg, the mean stage for November, 1887, "was minus 3.0 feet," being "4.2 feet lower" than the mean for November, 1886.

Notwithstanding this remarkably low stage of the river, the mean stage at New Orleans during November, 1887, was "plus 2.0 feet," being "one-tenth higher" than the mean for November, 1886.

The lowest water at New Orleans during November, 1887, was three-tenths of a foot higher than the lowest stage in November, 1886.

The Chief Signal Officer states, in his letter to me of April 9th, 1888, as follows: "There is shown to be a relatively high stage of water at New Orleans. The cause of this may be due to the fact that there is a gradual obstruction to flow, owing to accumulations of some sort in the vicinity of New Orleans. The cause is hardly to be looked for in the gauge, yet it is possible."

Assuming the gauge to be correct, the relatively high stage at New Orleans would show a deterioration in the channel of the river. The cause of this deterioration is found in the artificial works that have been placed in the river, in conjunction with the deposition of sedimentary material consequent upon these works; these together form the obstruction and heap up the waters of the river. The artificial works referred to are at New Orleans, and in the passes.

MR. B. B. CHAMBERLIN spoke of some interesting quartz crystals from New York Island. Crystals of smoky-quartz were found mounted on pedestals of milky-quartz. The former were one-third inch in diameter, doubly terminated with very short prismatic faces. Of larger size were prisms of limpid quartz with caps of amethyst, some of which are removable.

DR. OLIVER P. HUBBARD referred to some large quartz

crystals from Japan, of clear quality; one crystal being 5.94 inches in diameter.

Prof. J. S. Newberry exhibited a jaw of *Rhizodus*, and presented the following

NOTE ON A NEW SPECIES OF RHIZODUS, FROM THE ST. LOUIS LIMESTONE AT ALTON, ILLINOIS.

At the meeting of the Academy held May 2d, 1887, I exhibited jaws, teeth, and bones of a large ganoid fish discovered by Mr. William McAdams in the Mountain Limestone at Alton, Ill., and this is briefly described in the Transactions of the Academy, Vol. VI., p. 137, and named *Cœlosteus ferox*. I have now the pleasure of exhibiting to the society portions of the under jaw of an allied, but still larger, fish recently found by Mr. McAdams in the same formation. This evidently represents a species of *Rhizodus* much like *R. Hibberti*, Ag., from the Carboniferous limestone of Scotland, of which the great laniary teeth are figured in most text-books on geology. The specimen now exhibited forms the anterior half of the dentary bone, which carries a large number of acute, conical, striated teeth, about half an inch in length, with three great laniary teeth, of which one is located near the symphysis, the others respectively four and a half and seven and a half inches further back. Of these the anterior only is perfect; this projects about two inches above the margin of the jaw, and is deeply implanted in its substance; the point is rounded off by wear, the sides are compressed, the margins acute, the base strongly fluted. It differs from the corresponding tooth in the Scotch species of *Rhizodus* in being more compressed and double-edged. This has suggested the specific name *Rhizodus anceps*, given to the species.

The discovery of this specimen is of special interest, as proving the existence of an unmistakable species of *Rhizodus* in North America, contemporaneous with the great Scotch ganoid, and equally large.

Several nominal species of *Rhizodus* have been described from the Carboniferous rocks of the United States, such as *R. lancifer*, N., *R. quadratus*, N., *R. occidentalis*, N., all from the Coal Measures of Ohio and Illinois, but it is by no means certain that any of these belong to the same genus with *R. Hibberti*, Ag.

Sir William Dawson has described a fragment of a fish jaw from the Lower Carboniferous of Horton Bluff, Nova Scotia, under the name of *Rhizodus Hardingi*. This is apparently a true *Rhizodus*, and it is probable that the genus, strictly defined, will be found limited to the Lower Carboniferous rocks.

MR. GEORGE F. KUNZ exhibited a diamond crystal, found near Atlanta, Ga.; an elongated octahedron, of three and one-eighth carats, with a yellow tinge.

MR. SETH E. MEEK communicated a paper,[1]

NOTES ON THE FISHES OF THE CAYUGA LAKE VALLEY.

(Published in the Annals, Vol. IV.)

Remarks were made by the PRESIDENT, DR. O. P. HUBBARD, and MR. L. E. CHITTENDEN.

April 23, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

A good audience present in the West Lecture Room of the Library Building, Columbia College.

The third lecture of the Popular Lecture course was given by PROF. GEORGE E. POST, of Beirût, Syria, on

THE PHYSICAL GEOGRAPHY AND GEOLOGY OF SYRIA AND PALESTINE.

The geographical region included in the above title is divided into five parallel strips, running north and south. The first of these is the coast.

The sea-coast plain varies in width from fifteen miles to zero, and rises from the sea level to an elevation of 400 feet. The plain of Philistia, in the south, is its broadest portion. It narrows gradually until, at Carmel, it is not over a hundred yards in width to the base of the promontory. From Carmel it widens into the plain of Acre, which is about four miles broad, and which is continuous with the plain of Esdraëlon, which bisects Palestine into northern and southern mountain chains. North of Acre it becomes gradually narrower, until at the ladder of Tyre and adjacent rocky promontories it disappears. North of these passes, which are almost as defensible as Thermopylæ, the plain reappears, and is of width varying from zero or a few

[1] The paper was read by Mr. A. L. Ewing.

feet to several miles as far as the pass of Nahr-el-Kelb, which overhangs the sea about five miles north of Beirût. From this point to Kolmoon, the mountains come down to the sea, except at a few points where they recede to form small plains, usually the sites of villages. From Tripoli northward the plain gradually widens, until at 'Akkar its greatest width is about five miles. Thence it forms a narrower strip along the Nuasairy coast to Lattakia, from which it again broadens and extends to the foot of Cassius, where it ends in the bold spur of this mountain which projects into the sea.

The most noteworthy geological feature of this region is the blown sand which piles up on the southern aspect of all the headlands, and often overwhelms the fields and orchards, and sometimes the villages and ruins.

A change which has taken place in the drift of these sands in the course of twenty years, illustrates the influence of man over geological changes. The sand which is thrown up by the sea on the shore, is that which is brought by the prevailing currents from the Lybian coast. Before the Canal of Suez was constructed, this sand had uninterrupted course. Since the canal was made, however, and its approaches have been regularly dredged, the sand is no longer brought in considerable quantities, and the increase of the dunes is very greatly lessened. At Beirût, eighty years since, the inhabitants and proprietors of a quarter of the suburbs which had been overwhelmed petitioned the government to resume possession of the sandy tract, that they might be relieved from the taxes. This was done. Since the construction of the canal, the sand instead of overwhelming new tracts, has partially uncovered those already covered, and the proprietors vainly sought from the government to re-establish their property rights over what had now become valuable building sites.

An archæological discovery of interest was made during the excavations for the foundations of the boys' school in Sidon a few years since. At a depth of several feet a Roman foundation was met with. Beneath this was a layer of blown sand, and beneath this a layer of ashes, charred bones, flint knives, and a pottery whistle which could be made to sound.

The soft sandstone of the promontories of Jaffa, Tyre, Sidon, Beirût, Tripoli, has doubtless been formed from ancient dunes. I have found the fossil leg-bone of a bovine quadruped, and the fossil body of a whale's vertebra in this sandstone.

An hour north of Beirût, at the top of the pass over the promontory of Nahr-el-Kelb, is a mass of bone breccia, made up of the bones of extinct animals, mixed with flint chips. No human bones were discovered among them. In a large cavern near the

mouth of the river Antelias, a considerable number of flint knives and many bones of still existing animals have been found. Flint implements have also been found on the surface of the sands south of Ras Beirût.

A student of the Syrian Protestant College brought to its museum the calvarium, lower jaw, and part of the pelvis and femur of a man, imbedded in a stalagmitic deposit taken from a cave north of Beirût. Unfortunately he did not know the locality or the circumstances under which the specimen had been obtained.

Among the objects of interest along the coast is the Eocene deposit of the Lattakia Plain. This bed of marl is elevated from 250 to 350 feet above the sea, and deeply furrowed by the branches of the streams which empty into the sea south of Lattakia. In the gray soil washed down the sides of these ravines are immense numbers of shells, many of them in an excellent state of preservation. More than forty species were collected by the author in 1884, and the deposit has been described in an article in *Nature* in 1885. Similar deposits will doubtless be found in the plain of 'Akkar and the Marqab. The writer found a similar deposit half-way to the summit of the hill above the town of Zante, on the island of the same name. This deposit was described in *Nature* for 1887.

The second strip consists of the westernmost of the two great mountain ranges, and begins at Ras Mohammed, at the head of the Red Sea proper, at the junction of the Gulfs of Suez and 'Aqabah. The rugged range of Sinai, which occupies most of the peninsular triangle between the two gulfs of the Red Sea, rises steeply from Ras Mohammed to the peaks of Um-Shomer 8,300 feet, Jebel Katarina 8,400 feet, Jebel Musa, 7,600 feet, and then sinks gradually to the sandy plain of Debbet-er-Ramleh, which joins the heads of the two gulfs, and separates the range of Sinai from the plateau of the Tîh-Jebel Serbâl, a lateral spur of the Sinaitic range, half-way from Ras Mohammed to Debbet-er-Ramleh, projects like a gigantic bastion to the west, overhanging the sandy plain of Tôr. The highest peak of this lateral range reaches an altitude of 6,500 feet.

It is difficult to conceive a wilder scene of rugged desolation than that which is unrolled before the view from the summit of the Sinaitic range. The entire absence of vegetation, and even of soil, gives to the landscape the sharp outlines and the vivid colors of a geological chart. The valleys are for the most part narrow and tortuous, with steep, often precipitous sides, their floor being nothing but the bed of an occasional winter torrent, and strewn with gravel and boulders. In a few places there are high banks of gravel and soil on one or both sides of the valley,

showing that there was once a chain of lakes along the wadi. The main mass of the chain is a pink syenite, or gray granite, but it is everywhere rent by great convulsions of the age of igneous action, and injected with seams and dykes of green and black diorite, and red, gray, yellow and purple porphyry. These dykes often extend for many miles across the spurs of the chain, traversing the intervening wadis, and can be traced by their sharply defined margins and vivid coloring, which is not obscured even by a lichen.

Toward the northern portion of the range the granite is overlaid by gray, red, white, and black sandstone. The westetn flanks of the peninsula are all composed of jagged peaks, carved out of these sandstone rocks. Nothing could be more striking than the contrasts at every turn between whole mountains, one white, one black, one red and one gray, often touching at their base, and other mountains with straight or contorted strata of many colors, nowhere toned down or overshadowed by vegetation, and standing out in the dry crystal atmosphere of the desert.

In the northern part of the range, a few miles before it sinks into the plain of Debbet-el-Ramleh, the granite dips under the sandstone, and one can step from one to the other. Almost at the northernmost peak of the Sinai range, several hundred feet above the level of the road through the wadi which leads from the foot of Surabît-el-Kadim to Debbet-er-Ramleh, there are some horizontal strata of limestone over the sandstone. The sharp definition of these strata, seen in their elevated position, is one of the most interesting geological features of the peninsula. They are the last plates of the limestone of Sinai which has survived the long process of denudation that has uncovered the sandstone and the igneous rocks of the southern portion of the peninsula.

The sandstone rocks of northern Sinai dip under the shifting sand at the southern edge of Debbet-er-Ramleh.

The plain of Debbet-er-Ramleh is a strip of sandy desert about ten miles wide, connecting the heads of the two gulfs of the Red Sea. It is not straight but V-shaped, with its angle to the southward. Into the angle formed by its two sides projects the gigantic escarpment of the plateau of the Tih, which rises almost perpendicularly several hundred feet above the plain. This plateau is the continuation of the limestone strata of which we noted the traces on the other side of the plain overlying the sandstone. The sandstone does not re-appear in our progress northward until we reach Lebanon, and the granite and porphyry do not crop out again until we strike the chain of Cassius, nearly 400 miles away.

The plateau of the Tîh, or the wilderness of the wanderings of the Children of Israel, is a plain reaching from the Suez Canal on the west to the 'Arabah on the east, and from Debbet-er-Ramleh on the south to the hill country of Palestine on the north. Several ranges of hills intersect this plateau. One of them near its central meridian is composed of the compact cretaceous rock of the Palestine and Lebanon chains. Another, Shuweishât-el-'Ujmet, is composed of a crumbling cretaceous marl, of a glaring white color. The marked physical feature of the plateau is the system of wadis which furrow it, and unite to form the Wadi-el-'Arish, the ancient "Torrent of Egypt," which debouches into the Mediterranean midway between the Suez Canal and Gaza. It is a miniature of the "bad lands" of our own west, but without water in the bottom of the wadis or grass in the uplands.

Many parts of the floor of the Tîh are covered for miles with flint chips, many of them disc-shaped, from half an inch to an inch or two in diameter, with more or less rounded edges and smooth surfaces. I did not see nodules, encased in chalk, as is common in the rocks near the sea-coast of Syria, nor was I able to account for the vast number of these chips and their even distribution over the almost level surface. Their rounded edges and smooth surfaces may be accounted for by the attrition of small particles of sand blown over them by the strong winds of the desert.

Some parts of the white chalk cliffs of the 'Ujmet are studded with small crystalline masses of iron pyrites, and occasional masses of gypsum. I did not stumble on any fossils in these formations, but I did not search for them.

There are not a few tracts of arable land in the Tîh, and a considerable number of wells of potable water. It is probable that water could be had by boring anywhere in the plateau. On approaching Palestine, the area of cultivable soil and the number of springs increase. The land also rises gradually along the central meridian until it is merged in the hill country of Judea. The western aspect of the plateau sinks gradually toward the sea level, and a few hours south of Gaza presents a series of east and west ridges of sand with shallow intervening valleys, with a considerable vegetation consisting of coarse grasses and occasional clumps of tamarisks and other small trees or bushes. At the bottom of all the wadis, both of Sinai and the Tîh, there are tamarisk and acacia trees; and a rich and varied desert flora rewards the botanist for his weary camel rides under the scorching sun.

Dean Stanley, in his "Sinai and Palestine," has well described the gradual transition from the barren wastes of the Tîh to the rolling uplands of Judea. By imperceptible gradations one is

transferred from the waterless desert to a land of vineyards and olive trees, and waving fields of grain, and villages teeming with semi-civilized inhabitants.

The hill country of Palestine consists of an almost continuous backbone of limestone, extending for a hundred miles. The general height of this narrow plateau is about 2,600 feet. Here and there it rolls in rounded summits to a height of 2,900 or 3,000 feet. A few of the peaks, as Olivet, Nebi-Samwîl, Ebal, Gerizim, Tabor, and Little Hermon, are more pronounced, and the last four stand out as distinct mountain masses of considerable elevation above the general surface of the plateau, and from 1,600 to 3,000 feet above the sea. The rocks of Palestine are not so rich in fossils as those of Lebanon, but nevertheless contain many interesting species. My absence from our museum and any notes will make it impossible to cite the names of species. The plateau breaks away gradually to the west, and much more precipitously to the east, where it overlooks the deep valley of the Jordan. Narrow ravines furrow its sides, and on the east become profound chasms, few of which, however, carry any water save during the heavy storms of winter.

The soil which once covered the mountains of Palestine to their summits has been washed into the valleys, and these gray hills are often quite barren. But the limestone is constantly disintegrating, and the peasants terrace up the mountain side, and irrigate the new made land; it produces astonishing harvests.

Between Galilee and Samaria is the depression of the plain of Esdraelon, pushing far eastward, and lowering the backbone of the chain of hills so much that some English engineers have conceived of the possibility of piercing this isthmus with a canal, and letting the waters of the Mediterranean into the Jordan valley, a project to which the Turks will never give their consent. Near the eastern extremity of this valley there are outcropping of trap rock. The frequent earthquakes in this region show that there is still unexpended plutonic force beneath it.

Between the northern border of Galilee and the southern slopes of Lebanon is a strip of rocky plain, about fifteen miles broad, elevated only a few hundred feet above the sea. Through this plain the Leontes and the Zaharâni force their way westward to the sea.

Mt. Carmel is an isolated spur of the north and south range, tending northward from the latitude of Samaria to the coast at Haifa. Conder has found wild deer in this secluded range. It is heavily wooded in places and has an interesting fauna and flora.

Lebanon rises from the plain which separates it from Galilee,

and runs northward for about a hundred and twenty miles, and terminates in the valley of the Nahr-el-Kebîr, the ancient Eleutherus. Its southern portion is called Jebel Riehân, and is about 5,000 feet in height. In this part of the mountain there are some deposits of copper ore, of which I have not seen specimens. Thus far, the mines have not been worked in modern times, and it is doubtful whether, with the scarcity of fuel for smelting purposes, they would now be profitable.

At the latitude of Sidon the main chain of Lebanon begins at the twin peaks called Tom-ât-Niha, a saddle-shaped peak about 7,000 feet high, and runs northward in the form of a hog's-back about 25 miles in length, and 6,500 feet high, almost denuded of trees. Nevertheless, at several points there are remnants of the ancient forests of the cedars of Lebanon, which once clothed the whole range.

At the latitude of Beirût there is a depression of the chain to a pass about 5,000 feet high, over which goes the Beirût and Damascus carriage road, and by its side the ancient road which probably was always the main highway from the coast to the valley of Coelesyria and to Damascus.

Just north of the Damascus road, overhanging it, is Jebel Kenîseh (Church Mountain), so called from its resemblance to the nave of an oriental cathedral. This peak is 7,500 feet high. Snow lies on its top until late in July.

North of Jebel Kenîseh is another depression of the chain of Lebanon to a pass about 6,000 feet high, and then the grand truncated pyramid of Jebel Sunnîn, 8,500 feet high. This pyramid is triangular at the base and apex, the sides of the apex triangle being about three miles long.

The strata of both these peaks, as of almost all the elevated regions of Lebanon, are nearly horizontal, and being quite bare of trees and almost of all vegetation except that growing in the chinks of the rocks, they are visible at a great distance, and form a striking feature in the landscape.

The summits of both Jebel Kenîseh and Jebel Sunnîn, but especially the latter, are honeycombed with funnel-shaped depressions, some of them a thousand feet across and several hundred feet in depth, caused by the subsidence of the limestone strata in the centre. The snow collects in these excavations in very deep drifts, and the water which melts from them percolates through these funnels into immense reservoirs in the heart of the mountain, and bursts out at different levels down the mountain side. Two of these great springs, the Neba'-el-Leben, (the Fountain of Milk), and the Neba'-el-'Asal (the Fountain of Honey), gush forth at the base of the pyramid of Sunnîn, as large as the largest Croton mains, and the ice-cold water leaps

in beautiful cascades down the mountain side to swell the waters of the Dog River, the main body of which, however, issues as a subterranean river from vast caverns nearly at the sea level.

Many of these subterranean streams flow away along the level strata of the lower ranges of Lebanon, and break out in fountains at various points. Standing on one side of a valley, one can trace the course of such a stream on the other side of the valley by the line of villages, surrounded with gardens, which owe their existence to the fountains fed by these underground rivers. In some cases these streams must flow for more than a hundred miles under the hills, before they break out in the copious fountains of Galilee and Samaria, which can have no source but this for their unfailing supply of water during the eight or nine months when there is no rainfall of importance. The magnitude of the reservoirs, which maintain the large perennial river system of Syria, such as the Orontes, the Leontes, the Barada, the 'Awja, the Jordan, the Mandhûr, the Zerqa, the Zerqa Ma'în, the Arnon, the Kishon, the Awwali, the Beirût river, the Dog river, the Nahr Ibrahim, the Kadîsha, and the Nahr-el-Kebîr, must be stupendous.

North of Jebel Sunnîn, the chain of Lebanon forms another featureless hog's-back about 7,000 feet high, for a distance of about thirty miles. Opposite Tripoli, tower the loftiest peaks of the chain, 10,500 feet in height. At the base of the loftiest of all, amid a grand amphitheatre of mountains, on the moraine of an ancient glacier, is the historic grove of the "Cedars of the Lord."

The summit of this lofty region of Lebanon is not honeycombed like Sunnîn with funnel-shaped craters, but consists of a shingly, friable limestone, forming two parallel chains of several miles in length, of rounded summits five or six hundred feet in height, with a broad, level valley between them. The snow banks on the northern exposure of these peaks are of immense length and depth, and generally last over the whole of the long, hot summer, and are still unmelted when overtaken by the snows of another winter. The region of highest elevation is about 25 miles in length. On the west face of its northern extremity is a bold escarpment, 2,000 feet in height, beetling over the plain of 'Akkar.

From the lofty region just described, the chain of Lebanon descends gradually through the rugged mountains of Bano to the valley of the Nahr-el-Kebîr, the ancient Eleutherus.

The valley of the Eleutherus is a broad plain, about 1,000 feet above the sea at its widest point, separating the chain of Lebanon from the Nusairy mountains. It forms the western arm of the conical depression which meets at Hems, and is in my opinion

the "Entering in of Hamath," the northern boundary of the promised land, but which was never in fact attained even in the palmy days of the Hebrew monarchy.

The striking feature of the geology of the mountains of Palestine and Lebanon is the generally level strata of limestone of the Cretaceous epoch. In places, especially near the coast, these strata are more or less tilted, sometimes quite vertical or partly reversed. The general aspect of the stone strongly resembles that of the Jura, but in many places there are large mountain masses of white chalk like that of the cliffs of Dover. Near the coast there are isolated flint nodules imbedded in the limestone masses, and sometimes strata of considerable thickness. In many places on Lebanon there are large numbers of geodes of quartz, with beautiful crystals in their interior, and others of chalcedony, generally of opalescent hues.

In many places of Lebanon, usually between the altitudes of 200 and 4,000 feet, are outcropping spurs of sandstone, generally red but sometimes yellow, white, or of variegated colors, like the sandstone of Wadi Maghârah and Sinai. At an altitude of from 3,000 to 5,000 feet there are beds of coal, too full of earthy materials and sulphur to be available as fuel. Iron ore is found in considerable quantities in Lebanon, and copper ore exists above Sidon.

Traces of glacier action are found at the cedars of Lebanon, which grow on a moraine, and at 'Ammîq, in Cœlesyria, where there is a long line of erratics extending from the mouth of a valley of Lebanon a couple of miles over the plain, which is the bed of an ancient lake.

The Nusairy chain is lower than Lebanon, its highest summit not being over 4,000 feet in height. It is unexplored geologically, but is presumably Cretaceous. It runs northward to the latitude of Basît, the ancient Poseidon, twenty miles north of Lattakia, where it is joined by the transverse range of Cassius.

Mt. Cassius is an isolated cone, rising almost precipitously from the sea to a height of 6,400 feet. It is a beautiful feature of the landscape, and commands a most extended prospect over the sea and land. Its base is granite to an altitude of about 2,500 feet, and the remainder of the mass cretaceous limestone.

The valley of the Orontes, making a sharp bend to the west, intervenes between the ranges of Cassius and Amanus. Amanus is a chain about 100 miles long, extending from Jebel Musa on the south to Ziaretdagh on the north. The southernmost mountains of this chain are composed of igneous rocks, granite, gneiss, porphyry and diorite, which have not reappeared since we left them in northern Sinai. Overlying these in places is the cretaceous limestone. As one goes northward the igneous rocks

disappear, and the mountain mass becomes wholly cretaceous. The valley of the Ak-Su separates Amanus from Akherdagh, the first range of the Taurus.

The eastern range of mountains, parallel to the long chain just described, commences in the Idumean range at the Wadi-el-Ithm, which separates it from the Arabian range stretching away into El-Hedjaz. The main mass of this range is composed of Nubian sandstone, of the same brilliant colors as that of North Sinai. Underlying the sandstone in the southern portion of the range, near the head of the Gulf of 'Aqabah, are ledges of porphyry. The highest point of this range is the reputed Mount Hor, on the summit of which, 5,600 feet above the sea, is the Arabian wady of Nebi Harûn, or Aaron's tomb.

The mountains of Moab are in reality only mountains as seen from the west, looming up grandly over the chasm of the Dead Sea. They are properly but the crest of the plateau of Moab, a level table-land, which has always been noted as a pasture ground. The section of the geological formations of this region, exhibited by the wall of the Dead Sea trough, shows Nubian sandstone at the base, and cretaceous limestone above. About the mouth of the great chasm of the Zerqa-M'aîn are outcroppings of basalt, forming majestic cliffs opposite the hot springs of Callirrhoë. These springs, the hottest of which has a temperature of 148° F., are impregnated with sulphur, and a variety of calcareous and other salts. They are in great repute among the Arabs for chronic rheumatism, liver and spleen diseases, and dropsy. The highest and only proper mountain of the Moabite chain is Jebel Husha', which is over 4,000 feet above the sea.

The chasm of the Zerqa (Jabbok) is the natural boundary between Moab and Gilead. From its steep northern declivity extends the mountain range, about which has lingered the name of Gilead from the earliest historic period. It is a park-like country, abundantly watered even in summer, with fertile valleys and admirable pasture land, stretching far away into the eastern desert. The highest peaks are Jebel 'Ajlun, about 4,000 feet, and Sal-'at-er-Rabadh, about 3,500 feet above the sea. From the tops of Jebel Husha', Jebel 'Ajlun and Sal'at-er-Rabadh, but especially the first, the views over western Palestine and the chasm of the Jordan are surpassingly magnificent. The geological formation of Gilead is cretaceous limestone.

The range of Gilead sinks gradually to the north and ends at the latitude of Irbid in the plain of Haurân. The break in the mountain chain continues northward, through the Jawalân, for about forty miles. A series of detached cones of volcanic rock, probably ancient craters, rising from the Jawalân plain, among

which Tel-el-Faras is prominent, commences the mountain system of Hermon and Anti-Lebanon.

The plain of Jawalân, the Leja, and Haurân, occupy the gap between Gilead and the Hermon range, and extend eastward to Jebel-el-Duruz. They are composed of volcanic emissions of more or less antiquity, and the soil is exceedingly fertile. The black basalt of this region furnishes the building material for most of the stone houses of Bashan.

The detached volcanic chain of Jebel-ed-Duruz forms the eastern boundary of this great table-land, and still presents several well preserved craters, the most marked of which are Tel-Shihan and Jebel-Julêb, 5,400 feet high feet. From the latter and its two companion craters has flowed the great lava sea of the Leja, one of the most remarkable on the globe. The surface of this great mass, thirty miles in length and breadth, is tossed into great waves, crested with lava foam, and rent by deep crevasses and cañons, in which the Druzes find their "Refuge" (the signification of Leja) from their Turkish and Arabic enemies.

The southern flanks of Hermon are volcanic. Lake Phiala is an extinct crater, filled with water. But the main mass of Hermon and its continuation northward in the range of el-Jebel-esh-Sharqi, or Anti-Lebanon, is cretaceous limestone. A range of old volcanic cones stretches away northward from Jebel-ed-Duruz to, and far beyond, the latitude of Damascus toward Aleppo.

Hermon is a little more than 9,000 feet high, and the range of Jebel-esh-Sharqi nowhere rises higher than 7,000 feet. It sinks gradually into the table-land, south of Hems, at the "Entering in of Hamath," before alluded to.

North of the "Entering in of Hamath," there is no proper mountain range, but only a series of low undulations which form a watershed between the Orontes valley and the Syrian desert.

Between the two great mountain systems just described is the fourth strip, the wonderful cleft of the Arabah, the Dead Sea, the Jordan, Cœlesyria, and the Orontes valley.

The Arabah is a broad chasm between the plateau of the Tîh and the mountains of Idumæa. A transverse dyke, of no great altitude, about one-third the distance from the head of the gulf of 'Aqabah to the Dead Sea, divides this valley into two parts. The southern belongs to the Red Sea, while the northern was probably a part of the much more extensive Dead Sea of the past. The floor of this great valley is seamed and riven into deep interior valleys and cañons, and is one of the most desolate regions on the globe. It exhibits, at various depths, all the formations of Sinai and Palestine.

At the southern end of the Dead Sea are extensive deposits of rock salt, overlooking the Sabkha or salt marsh of the southern shore. The Dead Sea itself, 1293 feet below the Mediterranean, is too salt to allow of any animal or vegetable life, and that notwithstanding the enormous inflow of fresh water from the Jordan, Zerqa Ma'în, Mujîb, and other tributaries. Ancient deposits at various elevations on the rocky walls which frown above the sea, show clearly that the level of the water was once much higher. Bitumen in small quantities floats upon the surface of the sea, and is washed to the banks, a circumstance which gave the sea its ancient name of Lacus Asphaltites. All around its banks are the gaunt, decorticated trunks and branches of Jordan driftwood, the skeletons of ages of death.

Near the northern end of the Dead Sea is a series of pits, the significance of which is not known.

The Jordan valley rises gradually from the Dead Sea to the Lake of Tiberias, which is 600 feet below the Mediterranean. At Tiberias, and at the base of the northern spurs of Gilead, on the opposite side of the Jordan valley, are hot springs, indicating the volcanic forces everywhere near the surface in this region.

From Tiberias the valley rises, until at the Huleh it is at the sea level, and thence rises gradually to the dyke which separates the Jordan valley from Cœlesyria, and through which the Leontes breaks away to the Mediterranean.

The valley of Cœlesyria is the bed of an ancient lake, which had an outlet to the north through the Orontes, and to the south through the Leontes, the former of which now rises from Lebanon, and the latter from Anti-Lebanon. The elevation of this fertile plain is about 2,500 feet above the sea. The soil is a rich dark loam, and yields abundant harvests even to the rude agriculture of that people.

The valley of the Orontes is bounded on the west by the Nusairy range, and on the east by the low hills formerly described. Just before it turns westward to the sea, it breaks through the eastern spurs of Amanus, near Darkûsh, and flows for miles at the bottom of an almost inaccessible cañon. The floor of the valley of the Orontes, near Hems, is strewn with basaltic masses of great antiquity.

The last of the five strips which constitute the leading physical features of this land is the plateau of the Syrian desert, which is well-nigh unexplored. This is bounded to the east by the watershed of the Dhohr-el-Barriyah (Backbone of the Wilderness), which separates it from the Euphrates valley.

The flora and fauna of this land are as rich as might have been expected from the great diversity of elevation, physiography,

geology, and meteorology, in so small an area. It was a fitting microcosm for the isolated people who were to receive and embody in writing an universal religion, which was to be the basis of the universal brotherhood of man.

April 30, 1888.

STATED MEETING.

The President, Prof. J. S. NEWBERRY, in the chair.

Forty-seven persons present.

The Secretary nominated for Corresponding Member, PROF. GEORGE E. POST, of Beirût, Syria, who was, by unanimous consent, at once elected by formal ballot.

PROF. J. S. NEWBERRY presented, by title, a paper

ON THE FOSSIL FISHES OF THE ERIE SHALE OF OHIO.

(Abstract.)

The Erie shale is a name given to the western extension of the Chemung and Upper Portage rocks of New York and Pennsylvania. The formation consists of clay shale with flaggy sandstones, and has, near the eastern line of Ohio, a thickness of about 1,500 feet; it thins westward, and in central Ohio has been reduced to a thickness of about 100 feet, and in places is altogether wanting. It forms the lake-shore from Erie to Cleveland, and is generally barren of fossils, but in certain localities has furnished many of the mollusks characteristic of the Chemung group in New York.

Quite recently Dr. William Clark, the indefatigable collector of fossil fishes, has discovered in the lenticular, calcareous concretions in the top of the formation in the valley of the Cuyahoga, near Cleveland, Ohio, some remarkable fish remains which are new to science. A series of specimens obtained from the same region by Prof. William Kepler, of Berea, Ohio, has recently come into my possession, and I give herewith a brief description of them.

1. *Cladodus Kepleri*, n. sp. A shark, which attained a length of 6 feet or more, with a diameter of body of about 8 inches; the mouth is terminal or nearly so, the teeth numerous, varying in size from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch in height, consisting of a rela-

tively large flattened, ancipital, divergently striated central cone, with two lateral denticles set on a comparatively narrow base; the mandibles are partially ossified, and retain their form; the eyes are large, and were inclosed in bony capsules; the skin of the under side of the body is transversely wrinkled and fibrous, above granulous; the pectoral fins are perfectly preserved, showing both rays and web; in the largest individual found, which must have been 6 feet in length, they are 7 inches long by 5 inches wide at the base, conical in outline, slightly falcate, and show about 20 rays, which are without articulations, simple toward the base, and forked at the summit; the dorsal and caudal fins are not well shown in any specimen of this fish yet obtained.

2. *Actinophorus*, nov. gen. Tiled-scaled ganoids of medium size, long and slender; body cylindrical; head pointed, bony; teeth numerous, conical, acute; fins without fulcra, delicate, many-rayed; scales narrow quadrangular, thin.

Actinophorus Clarkii, n. sp. Fish slender, about 2 feet in length by 2½ inches in diameter at the pectoral fins; head conical, pointed, well ossified, 7 to 8 inches long; branchiostegals numerous; pectoral fins broadly conical, somewhat falcate, 3 inches long by 1½ inches wide, containing about 60 fine parallel ossified rays; anal fin 18 inches from muzzle, relatively small, triangular in outline; caudal fin strongly heterocercal.

The affinities of this fish are apparently with *Acrolepis*, but it differs from the fishes of that genus by the absence of fulcra from the fins, and the thinner and more quadrangular scales.

3. *Dinichthys curtus.* Fishes of medium size; cranium triangular, from 12 to 15 inches in length; defensive plates of the under side of the body relatively short and thick; posterior lateral plates nearly square, slightly rhomboidal, 4 inches in diameter; posterior process 3 inches long; anterior lateral plates 8 inches long by 5 inches wide. This species also occurs in the Chemung of Pennsylvania.

4. *Dinichthys Terrelli* (?), Newb. With the fish remains mentioned above are portions of the body plates of species of *Dinichthys* which, with the material in hand, is undistinguishable from that so common in the overlying Cleveland shale.

5. *Dinichthys tuberculatus*, n. sp. Head unknown, body plates of small area, but very thick, and having exposed portions covered with large, stellate tubercles; supra-scapular plates about 3 inches in breadth and ½ an inch in thickness; external surface where not covered by the dorso-median or clavicle, tuberculated, and marked by the incised line running from the condyle to the posterior border, characteristic of the genus;

dorso-median plate 3 to 4 inches in diameter, strongly arched, thick.

PROF. GEORGE E. POST read a paper on

THE RACES AND RELIGIONS OF SYRIA AND PALESTINE.

Northern Syria, in the days of Ramses II., was inhabited by the Hittites, probably an Aryan race, whose capital was at Kadesh, on the Orontes, near Emessa, the modern Hems. Ramses achieved a great but barren victory at this point, 1350 B. C., but never pushed his conquests, or even retained them. His expedition must be considered a victorious raid, rather than a subjugation of the country. There is every probability that the Hittites (perhaps not to be confounded with the Canaanite race of the same name in Palestine) retained their supremacy in northern Syria, until their sway was broken by the Greek conquest, under Alexander.

Central Syria was settled by an Aramaic race, whose capital was Damascus, and whose fortress was Anti-Lebanon while the narrow strip of coast was the home of another branch of the same stock, the most ancient cities of which were Arvad and Sidon, and later Tyre and Acre. Lebanon was the great fortress of the illustrious Phœnician stock.

Palestine proper was settled also by an Aramaic stock, more or less mingled with the Hamitic races of Northern Africa.

The country east of the Jordan was partly in the possession of Aramaic colonists, and partly of the Amorites, who may be only Aramaic mountaineers, or a mixture of Aramaic and Bedouin stocks. The Arabs always hovered around the eastern frontiers of Palestine and Syria, and contributed their share to the fusion of races in that land.

With the entrance of the Hebrews into Palestine, the official language and dominant race of that section became Hebrew, but the Canaanite peasantry were never wholly expelled or extirpated, and the Aramaic language, as distinguished from the classical Hebrew, was the vernacular of the people of Palestine at the time of Christ. This dialect, largely mixed with Arabic, has survived in four villages east of Anti-Lebanon. The Syriac of Lebanon and the regions to the north-east, is another branch of the Aramaic tree. Its ripest fruit was the Peshito version, and the ecclesiastical literature which clustered around it.

The first serious break in the continuity of the Hebrew-Canaanite stock took place in the reign of Shalmaneser, 721 B. C., when the northern two-thirds of Palestine were depleted by the deportation of many of their inhabitants, and the subsequent importation of Semitic or Hamitic colonists from Mesopo-

tamia. The Samaritan dialect and the Samaritan race were the results. This race is now reduced to about 150 souls, all of whom are found in the city of Nablûs, the ancient Shechem. This sharply characterized race and language is one of the many remarkable survivals preserved in this unique land.

The next break occurred in the reign of Nebuchadnezzar, 586 B. C., when a similar though less general fate overtook the Jews. By the restoration, in the days of Ezra and Nehemiah, a much purer Hebrew stock was brought back than that which peopled Samaria. This stock seems to have gained the control of Galilee, and little by little curtailed the influence, and diminished the numbers of the Samaritans, until in the time of Christ the latter seem to have occupied only a portion of the small district of Samaria.

The subjugation of all western Asia by Cyrus, about 530 B.C., was not followed by an infusion of Persian elements into the population of Syria and Palestine, for it seemed to be the policy of the Persians to interpose a series of tributary Semitic states between their empire and that of Egypt.

When Alexander conquered Phœnicia, and his successors became the founders of empires in northern Syria and Egypt, the Greek race impressed itself on the people of the Phœnician coast, and of the valley of the Orontes. Greek art prevailed throughout Cœlesyria and the trans-Jordanic region; and in Graeco-Roman days were erected the wonderful structures of Baalbek, Palmyra, Haurân, Gilead and Palestine. Yet the Greek language seldom did more than give duplicate names to places, which held tenaciously to the old Semitic names as well; and when the Græco-Roman civilization gave place to the Arabian, the ancient names reappeared in an Arabic form, and generally survive to the present day. It is plain that Greek never became the language of the people, still less Latin, and that they have retained their Aramaic race peculiarities through all the checkered experiences of their history, to the present day.

It is not true, however, as stated in the *Encyclopædia Britannica*, that the Greek race has left no traces of its physical influence. On the contrary, many of the Christian inhabitants of the Phœnician coast have the straight nose, characteristic forehead, and general physiognomy of the best types of the ancient Greeks. Many of their women are extraordinarily beautiful.

The Roman conquest left less of race impress in Syria and Palestine than would have been inferred from its long dominion there. When, however, it is considered that the Greek half of the Roman empire was the nearest, it may be said that the

Roman conquest only followed up the Greek, and intensified its results.

The temporary triumphs of the Persian dynasty of the Sassanides impressed themselves but feebly on Syria and Palestine. The unfinished edifice of Meshitta, in Moab, and a few other incomplete monuments, alone remain to testify their short-lived and ineffective contact with the Holy Land.

The Arabian conquest, from 638 A. D., has not only infused a large Arabic element into the body politic of the land, but has brought to the surface the old Aramaic instincts of the people. The Arabic language has indeed replaced all other dialects, except in the four villages before alluded to, but the people of Palestine speak it in a form largely adulterated with Aramaic idioms and peculiarities.

The Crusades left permanent traces in the physical aspect of the people. In some towns, as Antioch, Tripoli, Sidon, and Bethlehem, these traits are very pronounced. The Turks have simply encamped, as a ruling caste, in the strategic and political centres, and have not mingled their blood much with that of the natives.

It will simplify inquiry into the races of this land, to say at the outset that it will be as impossible to trace and define them with accuracy as to separate the English into their component elements. All that follows must be considered approximative only.

The present races traceable in Syria are, 1. *The Arabic.* This is not the most numerous, though the most important, of all. It is divided into two branches, the *nomadic* or *Bedawîn*, and the *civilized* or *Hadhar*. The number of Bedouin varies according to the season of the year, as they migrate in search of pasture and water. The Anazi are computed at 300,000, but they range all the way to the Euphrates. They occupy the northern portions of the Syrian desert. The Beni Sakhr and 'Adwan occupy the regions of Gilead and Moab. The Jehalin, Azazimah, and other minor tribes, are found in the neighborhood of the Dead Sea and the northern borders of the Tîh, while the Tayyahah and the Towarah claim the Sinaitic peninsula. Of the religion of the Bedawîn we will speak more presently.

The *civilized* Arabs are strongest in the great cities, as Damascus, Aleppo, Hamath, Hems, Tripoli, Beirût, Sidon, and Jerusalem. They are not a pure Arabian stock, being largely intermixed with the conquered Aramæans, Jews, Greeks, Romans, and other races, who were incorporated by conversion into the body-politic of Islam.

The religion of the civilized portion of the Arabs is of a strict, orthodox, but not ultra-fanatical type. Where they are in con-

tact with large Christian communities, as in Beirût, they are becoming more and more liberalized, and adopting a system of popular education, which is even extending to girls and women.

A large part of the religion of the Mohammedans is simply a matter of custom. Women are practically excluded. Very much of the faith of the present population is a mere fetichism. They have great confidence in charms and incantations. Nearly every one wears numbers of tin cases, with incantations in them, bits of alum, teeth of animals, etc., strung on a wire which is worn around the neck to keep off the evil eye. They are all devout believers in genii, and in the power of the great name of God to ward off their malign influences: most of them still believe in astrology and fortune-telling. Of the legalized immorality encouraged by their system, it would be indiscreet to speak here. The total number of the half-civilized Moslem population of Syria and Palestine is about 750,000.

2. *The Bedawîn.* The Bedawîn are divided into two sorts, those who live in the regions nominally under the Turkish rule, or migrate into them during part of the year and pay tribute, and those who are outside the tributary boundaries. The former range over the whole country, usually after the harvests, or in the regions lying fallow, and pasture their flocks, and sell their produce. These pay a fixed tax in kind to the government, and, in case of pasturing in private lands, to the proprietors. They are not subject to the conscription. The true desert Bedawîn, who never encamp within the taxable limits, are free from taxation, even when they bring their products to these districts for sale, except so far as they pay octroi taxes.

The Bedawîn invariably answer when asked as to their religion, "Praise be to God, we are Moslems." But they have little more than the name to justify this statement. Few of them can read. With no fixed abode, they have no places of religious worship, except the tombs of their sheikhs and prophets, and the mosques of the cities which they rarely if ever enter. Mohammedanism with them is a thin varnish over the ancient heathen superstitions and fetichism of the Arabian peninsula. The Towarah of Mt. Sinai believe that the monks have the power of bringing rain or withholding it by their religious exercises.

The tents of the Bedawîn are of goats' hair, and are impervious to rain. They are simple sheets of this strong cloth, stretched over poles, and pinned to the earth on one side by day and on both sides by night. There is little furniture in the tents. The beds are rolled up in the day, and at night spread out on mats or sacking. There are a few rude chests in a tribe, in which the more valuable of their chattels are packed. Their wealth is accumulated only in the shape of flocks and herds.

The government of the Bedawîn is patriarchal. The *lex talionis* is in full force, and is the potent cause of continual wars and raids. In Arabia there is still the possibility, with the alliance of central Africa and south-western Asia, of new religious movements that may shake the world.

3. *The Mutawalis.* This is a Mohammedan community of a few thousand souls, living in central and southern Lebanon, the plain of Cœlesyria, and the Anti-Lebanon. They are probably of Persian origin, and adhere to the Shiite sect of Islam, which holds to the sole legitimacy of the line of Ali, the fourth Caliph. They are a dark-skinned, black-haired, ill-favored race. The doctrinal distinctions between the Shiites and the Sunnites are abstruse and exceedingly difficult of comprehension to a Christian mind, probably not less so to a Mohammedan. In such points as the Shiites differ from the Sunnites, it would seem to be owing to the incorporation of Zoroastrian, Manichæan, and other heresies and mysticisms. The true distinction is probably a political one. The rancor and animosity is, however, exceedingly pronounced. A Mutawali will not eat or drink from the same vessel as a Sunnite Moslem, or a Christian, or a person of any other sect. The state of morality is exceedingly low among them. They are the most ignorant and least hopeful of any of the non-nomadic races of the land.

4. *The Druzes.* There is little agreement as to the origin of the Druzes. They have the physiognomy of an Aryan rather than a Semitic race, and are by some supposed to have come from Persia. They are well-formed, athletic, of fine personal appearance and martial bearing, and of determined courage and persistency in war. They speak Arabic of great purity, usually with a very clear and classical pronunciation. Although numbering but 60,000 or 70,000 souls, they have maintained for centuries their independence of both Turk and Arab. In the frequent civil wars of Lebanon, the Druzes, although numbering only 50,000 souls, were generally able to maintain themselves against six times their number of the native Christians. The Druzes of Haurân, although but a few thousand, have been able to this day to maintain a sort of autonomy. When hard pressed by Turkish regulars, they take refuge in the crevasses of the great lava sea of the Leja, and set at defiance their pursuers. In their natural fortification of the volcanic mountain range of Jebel-ed-Duruz, they have a retreat for their villages quite secure from the imbecile Mohammedans, Christians, and Bedawîn of the surrounding plains of Haurân, and lay them all under tribute. There are also a few Druzes in Mt. Carmel and in Galilee.

In 1860, after the massacres of the Christians at Deir-el-Somr and Hasbeiya, the Druzes were overawed by the French occupa-

tion, and compelled to rebuild the ruined towns. Their chief men were exiled, and their martial spirit curbed, although not wholly broken. The new government of Lebanon, wisely sketched out by Lord Dufferin, is so just and equal, and so well maintained by a volunteer militia in which all sects are represented, that there has been no uprising of the Druzes of Lebanon since that date. Local disturbances in the lawless district of the Haurân are, however, of almost yearly occurrence.

The origin of the sect is attributed to Ismael Darazi of Cairo, in 1040 A. D. This leader supported the claims of El-Hakim-bi-Amrillah, the sixth Fatimite caliph, who claimed to be an incarnation of the divine intelligence. Being driven from Egypt he took refuge in Lebanon, where he converted a great number of the inhabitants. Haurân was taken possession of by refugees from this sect when worsted from time to time in its numerous wars in Lebanon.

Although named from Darazi, the first authoritative expounders of this sect branded Darazi as a heretic, and the Druzes continue to regard him as such. They regard Hamzi as a reappearance of the Messiah.

The cardinal doctrines of the Druzes are, (*a*) The incarnation of the indefinable, incomprehensible, ineffable, passionless Deity ten times, last in the person of El-Hakim-Biamrillah. The door of mercy stood open twenty-six years, and was then finally and forever closed. The number of Druzes is unalterable. The souls of the dying go into the bodies of new-born infants, and so keep the number of the Druzes ever the same. They believe that there are multitudes of Druzes in China. Mohammedans at death become donkeys, and Christians slaves, to serve Druze masters. They make no effort to convert ; on the contrary they keep their doctrines secret. Such as have been made known have been surreptitiously proclaimed. Few even of their own people are initiated, these being known as the 'Oqqals. A Druze is allowed to make outward profession of any religion which he may fancy to be for his advantage. God knows the heart, and what is in it, and judges by what a man really believes, and not by what he seems. Obedience is required to the seven great commandments of Hamze which are, 1st, truth in words (but only to Druzes) ; 2d, loyalty to Druze interests ; 3d, renunciation of every other faith ; 4th, separation from all others, they never intermarry with Mohammedans or Christians ; 5th, the recognition of the unity of God ; 6th, complete resignation to His will ; 7th, complete obedience to His orders. Prayer is an impertinence. The freedom of the will is maintained.

The initiated, who may be of either sex, meet in houses called khalwes, apart from the villages, often in "high places." The

rites of the Druzes have been published by numerous European translators.

Polygamy is not permitted. Divorce is permitted to the husband, but cannot be cancelled. Either party is free to marry again. They are neither willing nor desired to serve in the Turkish army, and so are not liable to the conscription. Among the sects born of Mohammedan influences they are thus far the most open to Christian influences, and a number of them are converts to Christianity.

5. *The Nusairîyeh.* This sect is found in the range of mountains lying between Lebanon and Amanus and the adjacent plains, and about Antioch, and in the plain of Adana. A fragment of the race is found at the base of Mt. Hermon. They may number 300,000 souls. By race they are probably Canaanite, mixed of course with the various races which have overrun the regions in which they live. They are half-heathen Moslems, sufficiently orthodox to be drafted into the army, but with a secret religion infected with many indigenous heathen superstitions and ceremonies. They believe in God, in the Koran, but certainly not in all its doctrines. They are extremely ignorant, and at a very low ebb of civilization. Their most common designation is Fellahin, *i.e.*, Farmers, which term in their district serves to point out their religious belief rather than their occupation. They are less fanatical than the Mutawalis. Like the Druzes they are martial in spirit, and are often in rebellion against the Turkish government. A few have been converted to Christianity by the American missionaries from Lattakiah, who are maintaining mission schools and preaching-stations among them. But for the persecution of the converts by the Turkish government and the restriction of missionary operations among them, doubtless large numbers of them would have become Christians. The particulars of their religious faith, if faith it can be called, were set forth a few years since by a nominal convert to Christianity, Suliemân, who afterwards became a Mohammedan.

They do not, like orthodox Mohammedans and Mutawalis, observe the canonical hours of prayer, and seem to have little faith in prayer at all. They practise polygamy, and marry near relations. Some say that they marry parents. In common with the half-Moslem sects, they believe in transmigration of souls. They are adherents of Ali, in this respect resembling the Mutawalis. They murder without pity any one known to divulge their secrets. Some have supposed that the name *assassin*, a corruption of Hashshashîn (*i.e.*, one who takes Hashish, or the Cannabis Indica) originated among this sect, who certainly put it in practice against those whom they regard as traitors. The

term and the principles of the Assassins, however, originated with the following named sect:

6. *The Ismaeliyeh.* This sect of Islam is found in small numbers in Syria, and only in its north-eastern parts. They are of mixed, but principally of Persian origin. Their name is derived from Ismael, the seventh caliph of the line of Ali, whom they follow. Like the Nusairíyeh, they are only nominal Moslems, with a loose morality, and a jealous and esoteric system of half-heathen mysticism, founded on a mixture of allegorical interpretations of the Koran with pagan superstitions. In the days of their greatest prosperity, in the eleventh and twelfth centuries, they attained a malign notoriety through the interior development of the military and religious sect of the Assassins, whose methods of cowardly secret murder have made the history of all Mohammedan states so tragical. In the period of the crusades, this society spread over Persia, Syria, and Egypt, and had the most terrible influence over the Christian and Mohammedan dynasties of that period. After the expulsion of the crusaders, the society was little by little broken up, and its few remaining adherents driven from Persia, Tartary and Egypt into the mountain fastnesses of northern Syria. Their political power is now broken, and they number only a few thousand peasants, who have little sphere for the exercise of their diabolical doctrines and practices.

Before leaving the Mohammedan and semi-Mohammedan sects, it may be remarked that, although intensely religious, they are, with the exception of a few of the inhabitants of the larger cities, very little instructed in their religion, and regard it more as a matter of family inheritance than of conscientious conviction. There is really more antipathy between Druzes and Nusairíyah than between either and the Christians. The sectarian divisions of Islam are stronger and more permanent than those between Catholic and Protestant. The only condition of the co-existence of the different Islamic sects in the same district, is political as well as religious autonomy. It is, therefore, not with direct and primary reference to the Christians that the political system of the Mohammedan government was adopted. It would continue, were Christianity to disappear from all Mohammedan states as thoroughly as it has done from Arabia.

7. *The Gypsies.* The number of the Gypsies of Syria is considerable, but not accurately known. They seem to be of Hindoo origin. They speak Arabic, and their own Arabicized Gypsy. They are nomads, subsisting by weaving sieves, cloth, mats and sacking, and by raising asses, thieving, fortune telling, and assisting as musicians and dancers at the weddings and

festivals of the other sects. They have practically no religion, but a modified fetichism.

8. *The Jews.* The Jews of Palestine and Syria are all of European extraction, having returned after the early days of persecution were over. The greater number are of Spanish origin. Those in Jerusalem are largely supported by the contributions of their co-religionists from Europe and America. Few of them have shown any inclination to acquire or cultivate the soil. They are generally bankers, money-changers, or money-lenders. Few of them have any commercial transactions. Considerable inducements have been offered to them to settle in Palestine, but they have not come in large numbers. A few years since, when many Jews were expelled from Russia, an effort was made to colonize them in northern Syria. But the Turkish government took alarm, and refused to allow them to settle, lest political complications should arise in consequence. There certainly seems to be no belief on the part of the Jews now in the country that they are to be its possessors, and any such doctrine would be strenuously resisted by the Mohammedan rulers and people, as well as by the native Christians, Druzes, Mutawalis, and Nusairies.

9. *The Samaritans* are a small community of 150 souls, all living in the city of Nablûs in Palestine. They use the Arabic language in the affairs of life, and the Samaritan, a Semitic tongue, in their worship. They reject all of the Old Testament except the Pentateuch. They regard Gerizim as the centre of their religious life, and themselves as the favored people of God.

10. *The Greeks.* This sect is not composed in any distinctive sense of persons of the Greek race, but is, on the contrary, the most composite of all the Christian sects, as the orthodox Mohammedans are the least specialized of the Moslem races. It contains all the race elements which entered into the body-politic when the Christian Church was first established, and may be considered as the resultant of the Phœnician, Canaanitish, Aramaic, Jewish, Greek, and Roman elements. They call themselves the "Orthodox." The Syrian branch of the Greek Church is, perhaps, the least bigoted, and the most susceptible of reforming and elevating influences of all the branches of that church. It numbers about 150,000 souls, scattered through most of the country, with the exception of the Nusairy mountains, and the Maronite section of Lebanon. They are taking a good stand in the education of the young, and do not discourage the circulation of the scriptures. They have both a Greek and an Arabic liturgy, and still adhere to the ancient calendar.

11. *The Greek-Catholics* or *Melchites* split off from the Greeks about 150 years ago, and now form a community of about 50,000

souls, principally in Lebanon and the adjacent cities. They are more advanced in general culture and a desire for education than the Greeks. They have a flourishing Collegiate Institute at Beirût, and have adopted the Gregorian calendar. Their liturgy is in Greek, but with an Arabic translation. The Greek-Catholics retain the marriage privileges of the Greek Church, but have included the later doctrines of Rome in their confession of faith.

12. *The Maronites.* This body is a fairly pure remnant of the Aramaic race. Its stronghold is in the lofty and rugged mountains of northern Lebanon, where it maintained more or less of independence until 1860. It numbers in all about 200,000 souls. Many Maronites are now to be found in the principal cities of Syria and in southern Lebanon. But the seat of their patriarch and the centre of their power is in the neighborhood of the Cedars of Lebanon.

There is an apparently insoluble problem as to the origin of this sect, authorities differing as to the time from the fifth to the eighth centuries. Their first bishop was John Maro. They were originally Monothelites, but in the twelth century, under the influence of the Crusaders, they accepted the doctrine of the Catholic Church. But it was not till 1465 that they were reunited, and they did not formally subscribe to the decrees of the Council of Trent until 1736.

In the seventeenth century the Maronites were taken under the direct protection of the French, and the French Consul at Beirût for a long time exercised viceregal powers over them.

Until 1755 the Maronites and Druzes were friendly. Since then there have been several civil wars between them, culminating in the famous massacre of 1860, which spread to Damascus. After this lamentable outrage, a government was established in Lebanon, quite different from any that had preceeded it. The ruler, with the rank of Mutasarrif and title of Vizîr, is nominated by the Sublime Porte, and confirmed by the six treaty powers, England, France, Russia, Austria, Germany, and Italy. He must be a Christian, but not of any of the native sects. The first of these governors was Daoud Pacha, an Armenian; the second, Franco Pasha, a Latin from Aleppo; the third, Rustem Pacha, a Latin from Constantinople; the fourth, Wassa Pacha, a Latin from Albania.

The liturgy of the Maronites is the ancient Syriac. They have a married clergy, and many peculiar ecclesiastical customs. Their clergy are better educated than those of the other Christian sects. Nevertheless, the Maronites are strongly ultramontane and bigoted, and are the least progressive of the Christians of the Levant.

13. *The Jacobites.* This sect of Monophysites was named after Jacob Baradæus, a monk of Phasilta near Nisibis, in the sixth century. A favorite illustration of their view of the absorption of the human nature of Christ in his divinity is: "Glass is made of sand, but the whole is only glass, no longer sand. Thus the divine nature of Christ has absorbed the human, so that the two have become one." Wolff regards them as of Hebrew origin, and they call themselves Bnai Israel. Nevertheless, it is not certain that they are a pure Hebrew race, the heresy of the Monophysites having extended widely through the East, infecting the Nestorians, who were certainly a mixed race, spread through all Asiatic Turkey.

The headquarters of this sect is at Mosul, and the greater part of the membership of 150,000 is in upper Mesopotamia. A few are found in some villages near Damascus, where they speak a corrupt Aramaic. A few are scattered through northeastern Syria. They are remarkable for their ascetic view of the religious life, and their compact vigorous hierarchy.

14. *The Armenians.* Few of the members of this large and important communion live in Syria. They are undoubtedly the purest, except, perhaps, the Bedawîn, Maronites, and Gypsies, of all the races of the country. They claim the origin of their faith directly from Christ, without the intervention of the Apostles. They have a famous convent on Lebanon at Bezulmar, and are found in most of the cities of Syria and Palestine, as bankers and merchants. A peculiarity of the priestly dress with them is the long black veil which hangs gracefully down their backs. As a community the Armenians of Syria are exceptionally intelligent and wealthy.

There is also a papal branch of the Armenian church, represented by a few individuals in Syria, chiefly at Aleppo.

15. *The Latins.* From the days of the Crusades there has been a Latin church in the East, composed either of survivals of the European hosts, or those who cast in their lot with them. They are few in number, but of great influence in the country, owing to their being the medium of pecuniary assistance from the Latin churches of Europe. It is through them that the educational work of the churches affiliated with Rome is principally conducted. They have large convents and schools, and the most imposing churches in the country have been built by them. The Capuchin, Lazarist, Benedictine, Jesuit, and other orders are largely represented.

16. *The Copts* have ecclesiastical establishments in Jerusalem, and a few scattered members in the commercial cities. They, in common with the Abyssinians, retain the rite of circumcision.

Their liturgy, which was originally in the Coptic, has been translated into the Arabic, their vulgar tongue.

17. *The Protestants* have been firmly established in Syria and Palestine. Those of Syria are for the most part Presbyterians, and those of Palestine Episcopalians. They number many thousands, and are the most intelligent and best educated of all the people of the country. Few of them, male or female, are unable to read. The Scriptures have been translated into pure and classical Arabic, and are very widely circulated, not only among Protestants, but, through their efforts, among the other sects of the land. Since the appearance of the Protestant version, the Jesuits have also translated the Bible. The educational institutions of the Protestant missionaries are of a high order, and have become the models for those of the other communions. Before the establishment of the Syrian Protestant College there was not a collegiate institution in Syria. There are now six in Beirût, besides the above named, belonging to the Mohammedans, the Greeks, the Greek-Catholics, the Maronites, the Jesuits, and the Hebrews. The Syrian Protestant college and the Jesuit institution are universities, with several faculties, and large apparatus of instruction.

The existence of this large number of sects and nationalities in Syria and Palestine, although in some senses a drawback to the prosperity and progress of the country, favors a larger religious toleration, and the success of the educational method of elevating the whole body politic, in no common degree. A "Young Syria" is growing up, free from the sectarian animosities of the past, and imbued with an ever increasing spirit of patriotism and zeal for knowledge. The power of fanaticism grows yearly less, and all sects are beginning to dwell more and more on the brotherhood of man.

To give practical expression to this idea, the German Order of the Temple has established an agricultural colony at Haifa, and another at Jaffa, where the foreign colonists live in brotherhood with the natives, and cultivate the soil according to European methods.

I cannot close this lecture without alluding to the great revival of learning which has been brought about through the influence of Protestant missions in Syria and Egypt. Common schools for both sexes have greatly multiplied throughout Lebanon, Cœlesyria, the neighborhood of Damascus, and Palestine, and along the Nile as far as Nubia. The native sects have been driven, by fear of proselyteism or by a more honorable spirit of emulation, to favor this movement. In many cases they have aided the missionaries in their efforts; in others, they have

themselves founded schools. The common schools have stimulated the desire for knowledge, and led to the establishment of academies, and these in turn to colleges and universities. The sluggish Mohammedan government has been aroused, and schools for Mussulman children of both sexes have been founded. Text-books have been translated and composed, scientific journals have been established, libraries are being founded in the principal cities, and a general movement of mind has been inaugurated throughout the historic countries whose past reminds us of what they are capable.

Already there is a beginning of political emancipation. Some of the municipal offices in Turkey are elective. In 1876 a parliament of the Turkish empire sat for a while in Constantinople, and the deputies did honor to themselves and the communities which they represented. This parliament was not dissolved until it had shown that the people of Turkey had begun to grasp the principles and methods of constitutional government. Had it remained, it would have brought this empire fairly within the circle of modern states.

A similar experiment was tried in Cairo in the days of Arabi Pasha, but the parliament proved too dangerous to the arbitrary government of Egypt, and was summarily dismissed.

But the people of those lands cannot be always repressed. They are rapidly coming to self-consciousness, and will yet assert their manhood and claim the share in self-government for which they are being fitted by the process of education which is going forward. When the day of their emancipation shall have come, there is a great future open to Syria and Mesopotamia. Fifty millions of people can support themselves in those regions. Railways to the Persian Gulf and throughout those fertile lands will develop their resources, and add their wealth to the world's commerce. Great cities will grow up on the Syrian coast, and along the Euphrates and Tigris. Damascus, and Aleppo, and Hamath, and Bussorah, and Mosul, and Bagdad, will assume more than their ancient importance and wealth. And the Arabian race, with its copious and expressive language, will become the carrier of civilization and Christianity to the recesses of Arabia and Africa, so long desolated by the curse of Islâm.

Remarks were made by the PRESIDENT and by PROF. TROWBRIDGE.

Upon motion of the Secretary, it was voted that the thanks of the Academy be transmitted to the General Secretaries of the *International Geological Congress*, in reply to their invitation to

the members of the Academy to participate in the meeting of the Congress at Berlin.

May 7, 1888.

REGULAR BUSINESS MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Seventy persons present.

The Report of the Council recommended as follows:

I. The election of the following nominees:

For Resident Members:

PROF. CHARLES B. BRUSH,
BENJAMIN SILLIMAN CHURCH,
JOHN PATTEN,
WILLIAM WATERS.

For Corresponding Members:

HIS EXCELLENCY R. KUKI, Tokio, Japan.
PROF. FRANCIS AUSTIN GOOCH, New Haven, Conn.
PROF. SETH E. MEEK, Cedar Rapids, Iowa.

II. The transfer from Resident to Corresponding Membership of Charles G. Am Ende, William Kelley, and Simon F. Mackie.

III. The acceptance of the resignations of George Gregory and W. M. Habershaw.

IV. The remission of certain dues.

V. The erasure of certain names from the list of Resident Members.

VI. The payment of certain bills.

The recommendations were severally adopted, with the exception of item IV., which was laid over one month, under the rule, and the candidates were elected by formal ballot.

The Recording Secretary reported that, in obedience to the

command of the Academy, he had issued a call for the members of the Academy who were interested in mineralogy to meet after adjournment of the Academy, April 16th, for the purpose of organizing a section of mineralogy. Such meeting was held, and a Mineralogical Section organized. Sixteen names were affixed to the roll, and Mr. George F. Kunz was elected Chairman of the Section, and Mr. John H. Caswell, Secretary.

Mr. Albert R. Ledoux exhibited a meteorite from near Pike Creek, thirty-five miles southwest of San Antonio, Texas. Its weight, when found, was thirty pounds. It contained fifty-seven per cent iron, and nine per cent silica.

The President exhibited azurite, with rosette crystallization, from the Copper Queen Mine, Clifton, Arizona. Also garnets from New York Island, of beautiful form, dodecahedral (I.), the edges replaced with trapezahedral face ($3\frac{3}{2}$), like the garnets from Alaska.

The President announced letters in acceptance of honorary membership from Louis Pasteur and John Tyndall, and of corresponding membership from La Princesse Héléne Koltzoff-Massalsky.

The President placed upon the blackboard a sketch of the fossil shark *Cladodus Kepleri*, which was described in the paper read by title at the previous meeting, and remarked upon the remarkable character of the fossil.

Dr. H. Carrington Bolton read a paper on

THE LUNAR SOCIETY, OR THE FESTIVE PHILOSOPHERS OF BIRMINGHAM ONE HUNDRED YEARS AGO.

The Lunar Society was an informal club or association of scientific men which flourished in Birmingham for nearly forty years. It was founded about the year 1766, by Matthew Boulton, Dr. Erasmus Darwin, Dr. William Small and their friends; they do not seem to have numbered more than eight or ten at any one time, and they met at each other's houses for dinner every month near the full moon, "in order," says Dr. Priestley, "to have the benefit of its light in returning home." Hence the name Lunar Society. The members were accustomed to sit down to dinner at two o'clock, and did not part until eight, exchanging

views with each other on topics relating to literature, science, and arts, each contributing his quota of entertainment and instruction.

Each member was allowed to bring with him a friend, and thus many distinguished guests were present at these philosophical banquets. The society occasionally held "meetings extraordinary," in honor of scientific magnates from abroad.

Among the members of the Lunar Society were the following eminent men of science.

Matthew Boulton, F.R.S. (1728–1809), mechanical engineer and inventor of improvements in the steam-engine. A partner of James Watt.

Dr. Erasmus Darwin, F.R.S. (1731–1802), physician, poet, and naturalist. Author of "The Botanic Garden."

Dr. William Small (1734–1775), an intimate friend of Darwin, Boulton, and Watt. He was an accomplished physician, chemist, and mechanist. He held the professorship of mathematics and natural philosophy in William and Mary College, Virginia, for some years, but returned to England and settled in Birmingham.

Thomas Day (1748–1789), a wealthy, eccentric philanthropist, best known as the author of "Sandford and Merton." A friend of Capt. Keir.

Richard Lovell Edgworth, F.R.S. (1744–1817), author and philosopher; he contributed papers to the Royal Society. A friend of Day and Darwin.

Dr. William Withering, F.R.S. (1741–1799), physician, botanist, and chemist. He analyzed the mineral witherite named in his honor.

James Watt, F.R.S. (1736–1819), inventor of improvements in the steam-engine, chemist, and engineer. Partner of Boulton.

Captain James Keir (17..–1814), chemist and author; proprietor of several chemical establishments at West Bromwich near Birmingham. A friend of Darwin and Small.

John Baskerville (1706–1775), inventor of superior type, and publisher of standard works.

Rev. Dr. Joseph Priestley, F.R.S. (1733–1804), the father of pneumatic chemistry, theologian, and philosopher.

William Murdock (1754–1839), mechanical engineer, superintendent of the works of Boulton and Watt. Inventor of the system of lighting by gas, and of many improvements in steam machinery.

Rev. R. A. Johnson, F.R.S., of Kenilworth.

Mr. Samuel Galton, F.R.S., a wealthy man of letters, well skilled in chemistry and natural history.

Mr. Samuel Galton, junior, his son.

Dr. Stoke, a physician of Birmingham.

Among the guests known to have been entertained were the following distinguished men of science and letters:

Josiah Wedgwood, F.R.S. (1730–1795), the well-known potter and inventor of the ware called by his name.

Sir Joseph Banks, F.R.S. (1743–1820), botanist, President of the Royal Society.

Sir William Herschel, F.R.S. (1738–1822), the most distinguished astronomer of the century.

John Smeaton (1724–1792), civil engineer, builder of Eddystone Lighthouse.

Dr. Samuel Parr (1747–1825), eminent English scholar and critic.

The Rev. Hugh Blair, D.D. (1718–1800), author of "Lectures on Rhetoric." Professor in the University of Edinburgh.

Adam Afzelius (1750–1836), Swedish botanist. He visited England in 1789.

Dr. Daniel C. Solander, F.R.S. (1736–1782), Swedish Naturalist and physician, Librarian British Museum.

Jean André de Luc (1727–1817), Swiss natural philosopher and geologist.

Dr. Pieter Camper, F.R.S. (1722–1789) Dutch naturalist and anatomist.

Mr. John Wilkinson, iron-master, brother-in-law to Dr. Priestley.

Mr. William Bewly, a surgeon and apothecary of Norfolk, author of letters on the chemistry of gases. A friend of Dr. Priestley.

Mr. Collins, an American "rebel."

Dr. Henry Moyes, of Edinburgh, lecturer on chemistry, though blind. He emigrated to America in 1785.

Mr. M. Robinson Boulton, son of Matthew.

The Rev. Joseph Barrington, Roman Catholic priest of Oscott, a small hamlet, seven or eight miles from Birmingham. Author of several historical works.

Of the original members, two, Small and Baskerville, died in 1775. Dr. Priestley did not become a member until 1780, and, Murdock being so much younger, must have joined still later. Apparently, the society kept no records of its meetings, and but scanty notices of its proceedings can be gathered from the correspondence of its members.

We have given 1766 as the date of the commencement of these social gatherings, but it is probable that they occurred still earlier, for when James Watt visited Soho in 1768 on his way from London to Glasgow, Dr. Small, Dr. Darwin, and Capt.

Keir were invited to meet him at "*l'hôtel de l'amitié sur Handsworth Heath*," as Matthew Boulton styled his hospitable mansion. The Society had not perfected its method of conducting affairs as late as 1776, for in this year Boulton wrote to Watt, who had settled in Birmingham:

"Pray remember that the celebration of the third full moon will be on Saturday, March 3d; Darwin and Keir will both be at Soho. I then propose to submit many motions to the members respecting new laws and regulations, such as will tend to prevent the decline of a Society which, I hope, will be lasting."

Boulton was of a thoroughly social disposition, and the formation of the Lunar Society was a natural outgrowth of his genial character. He took pleasure in gathering about him in his home persons of kindred tastes and pursuits, in order both to enjoy their friendship and to cultivate his nature by intercourse with minds of the highest pattern. He was a favorite alike with children and philosophers, with noble guests and simple workmen of Cornwall. London had not at that period absorbed to so great a degree the active intelligence of England, especially in the higher departments of science, art, and literature. The men of that period, though busy with their professional duties and domestic cares, were not so wholly engrossed in the turmoil of business which makes life a burden for so many in the present age, and found time for relaxation in convivial gatherings. In Liverpool, Roscoe and Currie were the centres of a social intellectual circle; at Warrington, Aiken, Enfield, and, for a time, Priestley, were the leading spirits of another; at Bristol, Dr. Beddoes and Humphrey Davy of a third; and at Norwich, the Taylors and Martineaus of a fourth. In London, Sir Joseph Banks, Dr. Solander, Sir Charles Blagden, Dr. George Fordyce, Drs. Milner and Maskelyne, Captain Cook, Sir G. Shuckburgh, Lord Mulgrave, John Smeaton, and Jesse Ramsden with Edgworth and others, met once a week at Jack's Coffee House, and afterwards at Young Slaughter's Coffee House for social converse. This assemblage had no distinctive name. Benjamin Franklin was a frequent attendant, and alludes to it in his correspondence. But the most distinguished gatherings of all were those of the Lunar Society at Birmingham.

The Patriarch of the Society was Dr. Erasmus Darwin, at least until he removed to Derby in 1782. "His fame as a doctor, philosopher, and poet was great throughout the Midland Counties. He was extremely speculative in all directions, even in such matters as driving wheel carriages by steam." Being very busy with his medical practice at Lichfield, he was not very regular in his attendance at the dinners of the Society, and excused himself for his absence by such a letter as the following:

APRIL 5TH, 1778.

DEAR BOULTON:—I am sorry the infernal divinities who visit mankind with diseases, and are therefore at perpetual war with doctors, should have prevented my seeing all your great men at Soho to-day. Lord ! what inventions, what wit, what rhetoric, metaphysical, mechanical, and pyrotechnical, will be on the wing, bandied like a shuttlecock from one to another of your troup of philosophers ! while poor I, I by myself I, imprison'd in a post-chaise, am joggl'd, and jostl'd, and bump'd, and bruised along the King's highroad to make war upon a stomach-ache or a fever." . . . [Signed] ERASMUS DARWIN.

The society evidently served the purpose of a scientific exchange, each member contributing at the monthly meeting results of his own observations, and reporting news from without the circle. Before the establishment of weekly journals of science, this exchange was the natural means of intercommunication, just as the Athenians gathered on Mars Hill "to tell or to hear some new thing" in the political world. The society seems further to have been chosen by persons from a distance as a channel for announcing their own discoveries or those of others to scientists who would appreciate and publish them. James Watt wrote to the Irish chemist Kirwan as follows:

BIRMINGHAM, Nov. 14th, 1783.

DEAR SIR:—Your obliging communication of Mr. Scheele's process of making the Prussian acid gave me great pleasure, and, according to your desire, I communicated it to our Lunar Society last Monday, who desire me to return to you their thanks. . . . JAMES WATT.

When Dr. Priestley dissolved his connection with Lord Shelburne, and removed to Birmingham in 1780, he was warmly welcomed by the members of the Lunar Society as a valuable acquisition. He had corresponded with Boulton, and was already celebrated for his publications and his discoveries in gas chemistry. His discovery of nitric oxide dates from 1772; that of ammonia, hydrochloric acid, and oxygen from 1774; sulphurous acid gas and silicon-tetrafluoride, 1775; and nitrous oxide (laughing gas), 1776. He had published three volumes of his "Experiments and Observations on Air," and was engaged on a fourth. Priestley's love of polemics in metaphysics and theology was reflected in his work in science, and though unassuming and gentle in disposition, his advent infused new vigor into the society, and henceforth gave a chemical turn to the weighty discussions of the feasting philosophers.

In his autobiography, Priestley refers to these meetings in the following language:

"I consider my settlement at Birmingham as the happiest event in my life, being highly favorable to every object I had in view, philosophical or theological. In the former respect, I had the convenience of good workmen of every kind and the society of persons eminent for their knowledge of chemistry, particularly Mr. Watt, Mr. Keir, and Dr. Withering. These, with Mr. Boulton and Dr. Darwin, Mr. Galton, and, afterwards, Mr. Johnson, of Kenilworth, and myself, dined together every month, calling ourselves the Lunar Society, because the time of our meeting was the full moon."

The invitations sent out by the host were not formal, but in the nature of friendly letters, in which hints were given as to the intellectual feast in store. Thus, on January 3d, 1781, Watt wrote to Dr. Darwin: "I beg that you would impress on your memory the idea that you promised to dine with sundry men of learning at my house on Monday next, and that you will realize the idea. For your encouragement there is a new book to cut up, and it is to be determined whether or not heat is a compound of phlogiston and empyreal air, and whether a mirror can reflect the heat of the fire. I give you a friendly warning that you may be found wanting whichever opinion you adopt in the latter question; therefore be cautious. If you are meek and humble, perhaps you may be told what light is made of, and also how to make it, and the theory proved both by synthesis and analysis."

To this communication, Dr. Darwin sent the following curious and characteristic answer:

Beau Desert, January 6th, 1781.

Dear Mr. Watt:—You know there is a perpetual war carried on between the devil and all holy men. Sometimes one prevails in an odd skirmish or so, and sometimes the other. Now, you must know that this said devil has played me a slippery trick, and, I fear, prevented me from coming to join the holy men at your house, by sending the measles with peripneumony amongst nine beautiful children of Lord Paget's. For I must suppose it is a work of the devil! Surely the Lord could never think of amusing himself by setting nine innocent little animals to cough their hearts up. Pray, ask your learned Society if this partial evil contributes to any public good, if this pain is necessary to establish the subordination or different links in the chain of animation. If one was to be weaker and less perfect than another, must he therefore have pain as a part of his portion? Pray, inquire of your philosophers, and rescue me from Manichæism.

As to material philosophy, I can tell you some secrets in re-

turn for yours, viz., that atmospheric air is composed of light, and the earth of water (and aqueous earth). That water is composed of aqueous gas which is displaced from its earth by oil of vitriol. Pray, make my best devoirs to all the Phlos., and pray tell Dr. Priestley that I wish he would try whether a plant insulated in ☿ will spoil air. E. DARWIN.

When Darwin removed to Derby, he wrote to the Society:

"I am here cut off from the milk of science, which flows in such redundant streams from your learned Lunatics, and which, I can assure you, is a very great regret to me."

In another letter he said:

"I hope philosophy and fire-engines continue to go on well. You heard we sent your Society an air balloon, which was calculated to have fallen in your garden at Soho, but the wicked wind carried it to Sir Edward Littleton's. Pray, give my compliments to your learned Society."

On another occasion, Darwin wrote to Boulton:

"I hope Behemoth has strength in his loins. Belial and Ashtaroth are two other devils of consequence and good names for engines of fire."

Judging by these letters, Darwin was certainly a lively associate.

The meetings of the philosophers at Mr. Galton's must have been among the most delightful. The host was a man of superior intellectual endowments, well skilled in the exact sciences, and a member of the Royal Society and of the Linnæan Society. He was of the Quaker persuasion, and a man of family and opulence. He at first resided at The Five Ways about one mile from Birmingham, but in 1785 moved to Great Barr House, a beautiful estate of Sir Joseph Scott, about seven miles further from town. The house was large and rambling, it had four or five different staircases and halls, and was more like an assemblage of several houses under one roof. It was situated in an amphitheatre of wooded hills, and was bordered by an old-fashioned Dutch garden full of fish ponds. In this comfortable mansion the Lunar Society was most hospitably entertained. Mr. Galton's daughter Mary Anne (afterwards Mrs. Schimmel Penninck) characterizes the members with a graceful pen. Mr. Boulton, whom she calls the Father of Birmingham, "was tall and of a noble appearance; his temperament was sanguine, with that slight mixture of phlegmatic which gives calmness and dignity; his manners were eminently open and cordial; he took the lead in conversations, and with a social heart had a *grandiose* manner like that arising from position, wealth, and habitual command. He went among his people like a monarch bestow-

ing largess. His forehead was magnificent; the organs of comparison, constructiveness, and of individuality were immense. The characteristics of Mr. Watt, his partner, were altogether different. Mr. Boulton was a man to rule society with dignity; Mr. Watt to lead the comtemplative life of a deeply introverted and patiently observant philosopher. He was one of the most complete specimens of the melancholic temperament. His head was generally bent forward or leaning on his hand in meditation; his shoulders stooping, and his chest fallen in; his limbs lank and unmuscular, and his complexion sallow. His intellectual development was magnificent. . . . Whilst Mr. Boulton's eye and countenance had something of radiance, Mr. Watt's were calm, as if patiently investigating or quietly contemplating his object. His utterance was slow and unimpassioned, deep and low in tone, with a broad Scotch accent; his manners gentle, modest, unassuming. In a company where he was not known, unless spoken to, he might have tranquilly passed the whole time in pursuing his own meditations. But this could not well happen; for, in point of fact, everybody practically knew the infinite variety of his talents and stores of knowledge. When Mr. Watt entered a room, men of letters, men of science, nay, military men, artists, ladies, even little children thronged around him. I remember a celebrated Swedish artist having been instructed by him that rats' whiskers make the most pliant and elastic painting-brush; ladies would appeal to him on the best means of devising grates, curing smoking chimneys, warming their houses, and obtaining fast colors. I can speak from experience of his teaching me how to make a dulcimer and improve a Jew's harp." "Quite different was the aspect of Dr. Withering; he was the personification of that which belongs to a physician and a naturalist; enormous were his organs of proportion and individuality, and great were his powers of active investigation and accurate detail. His features were sharpened by minute and sagacious observation. He was kind, but his great accuracy and caution rendered his manner less open, and it had neither the wide popularity of Mr. Boulton's, nor the attraction of Mr. Watt's true modesty."

Of Dr. Priestley she says: he was "a man of admirable simplicity, gentleness, and kindness of heart, united with great acuteness of intellect. I can never forget the impression produced on me by the serene expression of his countenance. He, indeed, seemed present with God by recollection and with man by cheerfulness." She differed from Dr. Priestley in his religious views, but pays a handsome tribute to his earnestness, candor, and sincerity.

Captain Keir she characterizes as "the wit, the man of the

world, the finished gentleman, who gave life and animation to the party."

Dr. Stoke she calls "profoundly scientific and eminently absent," and relates the following incident in which he was concerned. "On one occasion, when the Lunar Meeting, or 'Lunatics,' as our butler called them, were seated at dinner, a blazing fire being in the room, we were astonished by hearing a sudden *hissing* noise, and seeing a large and beautiful, yellow and black snake rushing about the room. My dear mother, who saw it was not venomous, said to me: 'Mary Anne, go and catch that snake,' which, after some trouble, and thinking all the while of little Harry Sandford and Tommy Merton, I succeeded in accomplishing. We were wondering where it could have come from, when Dr. Stoke said that, as he was riding along, he had seen the poor animal frozen on a bank, and put it in his pocket to dissect, but the snake had thawed and escaped from his pocket. The doctor praised me very much for my prowess, and as a reward he made me a present of my prisoner, which I long kept in a glass jar and carefully tended every day; at last, however, I gave him his freedom."

Of the eccentric Dr. Darwin the lady had less agreeable reminiscences. The doctor had been called professionally to see her mother; he arrived in a worn-out, muddy "sulky," fitted up with receptacles for writing and eating, stocked with sweet confections, of which he was fond, and heaped up with books from the floor to the front window. "We all hastened," she says, "to the window to see Dr. Darwin, of whom we had heard so much, and whom I was prepared to honor and venerate, in no common degree, as the restorer of my mother's health. What then was my astonishment at beholding him, as he slowly got out of the carriage! His figure was vast and massive, his head was almost buried on his shoulders, and he wore a scratch-wig, as it is called, tied up in a little bobtail behind." Meanwhile, amidst all this, the doctor's eye was deeply sagacious, his observation most keen, and his intelligence well calculated to inspire confidence in his patients. When conversation began, his flow of wit and anecdote was most entertaining and astonishing, in spite of an inveterate stammering.

Elsewhere she records the painful impression made on her by the doctor's irreligion.[1]

[1] We have ventured to quote, at great length, from Mrs. Schimmel Penninck's graphic reminiscences, because they certainly bear the impress of truth and are lifelike in their portraiture. She had every advantage of forming the acquaintance of the members of the Society, her father being active in it from the time she was eight years old until she was five and twenty, and a tenacious memory, added to a power of

During the years 1780 to 1785, pneumatic chemistry was the principal topic under discussion, for Priestley and Watt were each contributing his share to the much-vexed question of the constitution of water. Cavendish in London, Lavoisier in Paris, and Watt in Birmingham were three rival claimants for the honor of the discovery of the composition of water. Priestley, as a friend of Watt, communicated speedily the results of his experiments, sometimes it is reasonable to believe, over the festive board of the Lunarians, and left the conclusions to be drawn by others. As to the relative merits of the claimants, that is foreign to the purpose of this essay.

The Priestley-Wedgwood correspondence[1] shows that in 1783 the philosophers were greatly exercised over Priestley's discovery of the conversion of water into air, the fallacy of which he himself afterwards admitted.

The Phlogistic Theory, which had been the controlling spirit in chemical philosophy for nearly a century, received its death-blow at the hands of Priestley himself, when he isolated oxygen on the 1st August, 1774. But he, as is well known, failed to perceive the important bearing of his own discovery, and it was across the channel that Lavoisier and other French chemists were skilfully burying the corpse out of sight. The French theory of combustion was but slowly accepted by conservative Englishmen, and slowest of all by the friends of Priestley.

In the transition period, hydrogen was for a time believed to be the elusive phlogiston; to this phase of doctrine, Boulton alludes in a letter to Wedgwood dated March 30th, 1781.

"We have long talked of phlogiston without knowing what we talked about; but now that Dr. Priestley hath brought the matter to light, we can pour that element out of one vessel into another, can tell how much of it by accurate measurement is necessary to reduce a calx to a metal, which is easily done, and without putting that calx into contact with any visible thing. In short, this goddess of levity can be measured and weighed like other matter. For the rest, I refer you to the doctor himself."

A few months later, Priestley himself wrote to his friend, Josiah Wedgwood: "Before my late experiments, phlogiston was indeed almost given up by the Lunar Society, but now it seems to be re-established" (March 21st, 1782).

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discrimination of unusual delicacy, enabled her, in after years, to record her souvenirs. Her mother was a most intimate friend of Mrs. Priestley, and William Priestley was a playmate in her youth. ("Life of Mary Ann Schimmel Penninck," edited by C. C. Hankin. London, 1859.)

[1] See authorities at the close of this paper.

Again Boulton writes to his partner, Watt, July 3d, 1781.

"I dined yesterday at the Lunar Society (Keir's house); there was Blair, Priestley, Withering, Galton, and an American "rebel," Mr. Collins. Nothing new, except that some of my white spathos iron ore was found to contain more air than any ore Priestley had ever tried, and what is singular, it contains no common air, but is part fixable and part inflammable."

On September 20th, 1785, Watt wrote to Boulton :

"The Lunar Society was held yesterday at Mr. Galton's at Barr. It was rather dull, there having been no philosophical news lately, except Mr. Kirwan's discovery of an air from phosphorus, which takes fire of itself on being mixed with common or dephlogisticated air."

We imagine that the philosophers would have hardly regarded their feast as dull, could Mr. Kirwan have shown to them the beautiful yet nauseating experiment of spontaneously inflammable phosphoretted hydrogen. And a modern Academy of Sciences would be enthusiastic over such a notable discovery.[1]

The discussions of the philosophic *convives* were not, however, confined exclusively to chemistry. The period was one of great activity in the world of science; Laplace was applying his mathematical genius to the problems of astronomy; Herschel was sweeping the heavens with his gigantic telescopes; Galvani and Volta were laying the foundations of a revolution in electricity; Count Rumford in Bavaria, was devoting his great energy to industrial and social economy; Hutton and Werner were geologizing in their respective countries; Haüy was systematizing the innumerable crystalline forms occurring in nature; the Mongolfier brothers were experimenting with air-balloons, and prophesying the yet unsolved problem of aërial navigation; Capt. James Cook returned from his memorable voyages around the world full of adventure and novelties in nature; the application of steam to the driving of land carriages and the propelling of boats was gradually being perfected by patience and genius. These together with the metaphysical and even the political questions of the day, must have engrossed the attention of the talented friends who dined together at the full moon. The predilections of their guests sometimes determined the character of the subjects discussed. Thus, in the autumn of 1782, the venerable engineer Smeaton, having business in Birmingham connected with his canal, was invited to attend a meeting of the Lunarians at the house of Watt. Watt wrote of this evening's proceedings to his friend Boulton, then in London, as follows :

[1] Gengembre, one of Lavoisier's pupils, had discovered inflammable phosphoretted hydrogen in 1783, but Kirwan's discovery was made independently.

"Smeaton grows old and is rather more talkative than he was, but retains in perfection his perspicuity of expression and good sense. He came to the philosophers' meeting at my house on Monday, and we were receiving an account of his experiments on rotatives and some new ones he has made, when unluckily his facts did not agree with Dr. Moyes, the blind philosopher's theories, which made Moyes contradict Smeaton, and brought on a dispute which lost us the information we hoped for, and took away all the pleasure of the meeting, as it lasted two hours without coming half an inch nearer to the point." (October 26th, 1782.)

It has been surmised that the Lunar Society discussed the action of light upon nitrate of silver, and the application of this phenomenon to the production of pictures. This suggestion was made by Mr. W. P. Smith, at a meeting of the Photographic Society of Birmingham in 1863, and was based on the discovery in Mr. Boulton's library at Soho of certain photographic pictures on metallic plates. It was understood at the time that Boulton's rooms had been closed for fifty years, but this proved to be an error, and the pictures were probably made by a Miss Wilkinson who had access to the rooms, and who had experimented in photography soon after its invention by Niepce. It is well known that Thomas Wedgwood, son of Josiah, is said to have made "silver pictures" under Sir Humphrey Davy's eyes as early as 1791–'93, hence during the existence of the Lunar Society. A fac-simile of one of these early photographs is prefixed to Miss Meteyard's "Life of the Younger Wedgwoods," but she herself throws some doubt on its authenticity.

The philosophical converse of the learned men was sometimes enlivened by humorous interludes, such as the following: Dr. Darwin, whose levity in religious matters was notorious, had invented a speaking machine which pronounced "papa," "mamma," and other words quite accurately. Mr. Boulton, who perhaps had suffered from the caustic wit of the doctor, drew up the following satirical contract.

"I promise to pay to Dr. Darwin, of Lichfield, one thousand pounds upon his delivering to me (within two years from date hereof) an instrument called an organ that is capable of pronouncing the Lord's Prayer, the Creed, and Ten Commandments in the vulgar tongue, and his ceding to me, and me only, the property of the said invention with all the advantages thereunto appertaining."

[Signed] M. Boulton.

Soho, September 3d, 1787.

Witness, James Keir.

Witness, W. Small.

A wide range of topics was admitted in the discussions at the informal meetings. Mrs. Schimmel Penninck, already quoted, gives a vivid picture of an exciting scene in her father's house. It was in the summer of 1788, and Matthew Boulton presented to the company his son M. Robinson Boulton, who had just returned from a long sojourn in Paris. "I well remember," writes Mrs. Schimmel Penninck, "my astonishment at his full dress in the highest adornment of Parisian fashion; but I noticed as a remarkable thing that the company (which consisted of some of the first men in Europe), all with one accord gathered around him and asked innumerable questions, the drift of which I did not fully understand. It was wonderful to me to see Dr. Priestley, Dr. Withering, Mr. Watt, Mr. Boulton himself, and Mr. Keir manifest the most intense interest, each according to his prevailing characteristics, as they almost hung upon his words; and it was impossible to mistake the indications of deep anxiety, hope, fear, curiosity, ardent zeal, or thoughtful gravity which alternately marked their countenances, as well as those of my own parents. My ears caught the words 'Marie Antoinette,' 'Cardinal de Rohan,' 'diamond necklace,' 'famine,' 'discontent among the people,' 'sullen silence instead of shouts of Vive le Roi!' All present seemed to give a fearful attention. Why, I did not then well know, and in a day or two, these things were almost forgotten by me, but the rest of the party heard, no doubt, in the young man's narrative, the distant though as yet faint rising of the storm which a year later was to burst upon France, and in its course to desolate Europe."

It is proper to note that Mary Anne Galton was but eleven years of age at the time which she describes from memory in her later years.

In 1791 a popular outbreak occurred in Birmingham, which threatened the very existence of the Lunar Society. A riotous mob, led by designing men of the baser sort, took possession, as it were, of the town, and for four days (July 14th to 17th) pillaged and destroyed private property to the value of over one hundred thousand pounds. These July riots have often been described and details of the fanatical and violent proceedings do not belong to this place. We can but briefly say that the animosity was caused by political bias and religious intolerance, and was especially directed against Dr. Priestley and his friends who had openly expressed their sympathy with the French Revolution, and as Dissenters were known to be opposed to the Established Church. The enraged mob, at first small in number, but increasing to more than a thousand, attacked first a company of eighty gentlemen who were dining together at a public house to commemorate the anniversary of the French Revolution.

The mob broke the hotel windows, and shouting "*Church and King,*" sought out Dr. Priestley, who had not dined with the company. Not finding him, the mob rushed to the "New Meeting House," of which the Rev. Doctor was pastor, and destroyed it by fire. They then sought another Dissenting Chapel, and, having levelled it to the ground, marched over a mile to the residence of Dr. Priestley, which was plundered without mercy. His philosophical apparatus was ruthlessly destroyed and his library and manuscripts scattered to the winds. Dr. Priestley and his family barely escaped with their lives and never entered the town again. His cheerful temperament and philosophic habit of mind supported him wonderfully, but he never ceased to lament the loss of valuable manuscripts, in which were recorded the results of twenty years of labor and study.

During three succeeding days the mob continued its work of destruction, almost unchecked by the municipal government. They directed their attacks against the property and persons of Dissenters, and of those holding liberal political views; the houses of the estimable William Hutton, bookseller, of a poor Presbyterian parson Mr. Hobson, and the more costly mansions of Mr. Humphreys and Mr. William Russel, a particular friend of Dr. Priestley, were pillaged and burned to the ground. The members of the Lunar Society, popularly known as "Lunatics," were the especial object of their hatred and zeal. Shouting: "*No philosophers—church and king forever!*" they attacked Edgbaston Hall, the residence of Dr. Withering, but the timely arrival of the light-horse terminated their wretched work of plunder. Some persons, to escape their fury, wrote: "No philosophers" on the fronts of their houses. Boulton and Watt were not without apprehension of an attack, and placing arms in the hands of their workmen, addressed them on the criminality of the riotous proceedings, and obtained their promise to defend the establishment. But Soho was spared the dreaded attack, owing to the fact, says Watt, that most of the Dissenters lived in another direction.

As a sequel, some of the ringleaders were executed, and the sufferers were awarded partial compensation for their pecuniary losses. Priestley shook the dust of Birmingham off his feet, fled to London, and some three years later emigrated to the wild regions of the Susquehanna in search of peace.

It requires little play of the imagination to conjure up the exciting conditions of the first meeting of the Lunar Society after these frightful disasters. We have found no record or even allusion to this occasion, which called for all the philosophy the learned victims could muster.

Dr. Priestley, while suffering an enforced separation from the society of his fellow-philosophers, was not forgetful of them, and in 1793 he dedicated his treatise, "Experiments on the Generation of Air from Water," to his "valued friends, the members of the Lunar Society at Birmingham." In this dedication, he says: "There are few things I more regret, in consequence of my removal from Birmingham, than the loss of your society. It both encouraged and enlightened me, so that what I did there of a philosophical kind ought in justice to be attributed almost as much to you as to myself. From our cheerful meetings I never absented myself voluntarily, and from my pleasing recollection they will never be absent. Should the cause of our separation make it necessary for me to remove to a still greater distance from you, I shall only think the more, and with the more regret, of our past interviews." "Philosophy," he adds, "engrossed us wholly. Politicians may think there are no objects of any consequence besides those which immediately interest *them*. But objects far superior to any of which they have any idea engaged our attention, and the discussion of them was accompanied with a satisfaction to which they are strangers. Happy would it be for the world if their pursuits were as tranquil, and their projects as innocent and as friendly to the best interests of mankind as ours." Finally, he concludes by earnestly committing them all, though in religious persuasion differing from himself, "to the protection and blessing of that Great Being whose we are, and whom I trust we all serve, and who established that course of nature which is the object of our common investigation." And then the Rev. Doctor prays "with the greatest esteem and affection" for a happy reunion with them all in another state of being.

On another occasion, Priestley, writing to Watt, again expressed his affection for the members of the society in graceful language. After thanking Watt and Boulton for the gift of a copying machine (invented by the former), the doctor adds: "This and many other things will ever remind me of the obligations I am under to you, and the pleasing intercourse I have had with you and all my friends of the Lunar Society. Such another I can never expect to see. Indeed, London cannot furnish it. I shall always think of you at the usual times of your meeting." (Letter of November 2d, 1791.)

Even after his settlement in Northumberland, the doctor continued to communicate his scientific observations to his friends in the Lunar Society. On December 6th, 1795, writing to his friend the Rev. Theophilus Lindsay, Priestley explains that he forwards through Dr. Young a copy of a paper prepared for the Philosophical Society at Philadelphia, and says: "Please

to forward it to Mr. Galton the first convenient opportunity. It contains several new experiments, which must be thought of importance, especially with respect to the new French system with which, though universally adopted, I see more and more reason to be dissatisfied." This paper was entitled: "Experiments and Observations Relating to the Analysis of Atmospherical Air; also Further Experiments Relating to the Generation of Air from Water," and was read to the Society February 5th, 1796.

Still later, we find evidence that the cordial friendship of Priestley with Boulton and Watt seems to have been unbroken, except as distance prevented personal contact. In 1801, the firm sent Priestley a present of a "noble furnace and other apparatus for making large quantities of air," and the doctor, in acknowledging the gift, wrote thus: "I send every good wish to yourselves and all the other members of the Lunar Society, the advantages of which I most feelingly find the want of." (Letter of October 17th, 1801.)

The latest reference to the Lunar Society in Priestley's writings is probably that in the introduction to his essay, entitled: "The Doctrine of Phlogiston Established and that of the Composition of Water Refuted," published at Northumberland in 1803. In this he comments on the almost universal acceptance of the new theory of combustion, and says: "And now that Dr. Crawford is dead, I hardly know of any person, except my friends of the Lunar Society of Birmingham, who adhere to the doctrine of phlogiston."

Dr. Priestley is not the only one who records his attachment to this social organization and to its members individually. In his "Memoirs," Richard Lovell Edgworth writes: Our Society combined "men of very different characters, but all devoted to literature and science. This mutual intimacy has never been broken but by death, nor have any of the number failed to distinguish themselves in science or literature. Some may think that I ought, with due modesty, to except myself. Mr. Keir, with his knowledge of the world and good sense; Dr. Small, with his benevolence and profound sagacity; Wedgwood,[1] with his increasing industry, experimental variety, and calm investigation; Boulton, with his mobility, quick perception, and bold adventure; Watt, with his strong inventive faculty, undeviating steadiness, and bold resources; Darwin, with his imagination, science, and poetical excellence; and Day, with his unwearied research after truth, his integrity and eloquence—proved altogether such a society as few men have had the good fortune to

[1] Miss Meteyard, the biographer of Wedgwood, says he was not a member of the Lunar Society, but a guest.

live with; such an assemblage of friends as fewer still have had the happiness to possess and keep through life."

As the century drew towards its end, the Lunar Society gradually dissolved, its members dropping off one by one. Priestley had emigrated; Thomas Day was killed by a fall from his horse, in 1789; Dr. Withering died of a lingering consumption, in 1799;[1] Dr. Darwin was carried off by an attack of angina pectoris, in 1802; and the ever-welcome guest Josiah Wedgwood passed away in 1795; Capt. Keir, James Watt, and Boulton, the founder, were almost the only members surviving. The vacant seats remained unfilled and the meetings passed into history. The few lingering survivors found its associations too painful to be continued. But the influence exerted by the society did not die; it had stimulated inquiry and quickened the zeal for knowledge of all who had come within its influence, and this spirit diffused and propagated itself in all directions. Leonard Horner, who visited Soho in 1809, thus refers to the continued moral influence of the association: "The remnant of the Lunar Society," he says, "and the fresh remembrance in others of the remarkable men who composed it, are very interesting. The impression which they made is not yet worn out, but shows itself to the second and third generation, in a spirit of scientific curiosity and free inquiry which even yet makes some stand against Toryism and the love of gain." (Smiles.)

Social gatherings of men having kindred intellectual interests and pursuits have many advantages which are lacking in other organizations of a more formal character. An Academy of Sciences is the proper place for announcing discoveries in every department of learning, but the parliamentary forms necessary to dignified proceedings forbid or hamper the freest interchange of opinions and the formation of those personal friendships which a social organization like the Lunar Society so admirably fosters.

One of the members of the Lunar Society, Richard Lovell Edgworth, perceived this difference between the two classes of associations, and states the case in well chosen words. Alluding to the Lunar Society in his "Memoirs," he writes:

"A society of literary men and a literary society may be very different. In the one, men give the results of their serius researches and detail their deliberate thoughts; in the other, the first hints of discoveries, the current observations, and the mutual collision of ideas are of important utility. The knowledge of each member of such a society becomes in time dissemi-

[1] During his long illness, his friends said: "The flower of physic is withering."

nated among the whole body, and a certain *esprit du corps*, uncontaminated with jealousy, in some degree combines the talents of members to forward the views of a single person."

The Lunar Society has long passed into history, and the workers in science of this generation must content themselves with scanty reminiscences, and with the thought that we gaze on the smiling face of the same moon that shone on the festive philosophers of Birmingham!

Remarks were made by the PRESIDENT.

[In preparing this sketch we have made free use of the following works:

Muirhead's "Life of James Watt," London, 1858.
Muirhead's "Mechanical Inventions of Watt," London, 1854.
Smiles' "Lives of Boulton and Watt," London, 1864.
Krause's "Erasmus Darwin," London, 1879.
Edgworth's "Memoirs," London, 1820, 2 vols.
Brougham's "Philosophers of the Time of George III.," London, 1855.
Rutt's "Life and Correspondence of Priestley," London, 1832. 2 vols.
Jewett's "Life of William Hutton," London, n. d.
"Life of Mary Ann Schimmel Penninck," by herself, London, 1859.
Meteyard's "Life of Wedgwood," London, 1865. 2 vols.
Meteyard's "Group of Englishmen," London, 1871.
As well as of:—
Forty-one unpublished letters from Priestley to Wedgwood, loaned to the writer by Mrs. Robert A. Wainewright, granddaughter of the great chemist.]

MR. B. B. CHAMBERLIN read a paper on

THE MINERALS OF NEW YORK COUNTY, INCLUDING A LIST COMPLETE TO DATE.

Literature of Local Mineralogy.—Mineral Collectors.

The first record we have of New York as a mineral locality is in the *Mineralogical Journal*, conducted by Archibald Bruce, M.D., in the year 1814, of which only one volume was issued. The list of minerals there given is scanty, and these are chiefly from Corlear's Hook. Among the collectors appears the name of Mr. Fred. S. Cozzens, one of a family which has given much attention to local research.

In the year 1825, there was issued an important work entitled "A Catalogue of American Minerals," by Samuel Robinson, M.D.

The author devotes separate sections of descriptive matter to what is now New York County, viz., New York City and island, Corlear's Hook, Harlem Heights, Kingsbridge, Morrisania, and Bronx River.

The list of minerals shows no attempt at systematic arrange-

ment, and according to modern ideas requires considerable modification. Zeolite and mesotype are the indefinite titles of stilbite and other members of the same group. Tourmaline was often termed schorl, and the two names were in close conjunction in one column. Sphene bore the singular and lengthy title of silico-calcareous oxide of titanium.

In this work we are authoritatively informed that our island is one of the only three localities in the United States containing emeralds, the other two being Haddam, Ct., and Paris, Me. These so-called emeralds were undoubtedly beryls or apatite.

In 1838, Dr. L. D. Gale undertook a systematic survey of the island, beginning his work at Fourteenth Street and Tenth Avenue, near the northern limits of the then populated portion of the city. The result of his work is found in the "Report on Fourth District, N. Y. State Survey, Geology of the Island."

A later chronicler of our local mineralogy was a member of the New York Lyceum of Natural History, Mr. Issachar Cozzens, who published in 1843 a work entitled, "A Geological History of Manhattan or New York Island." He is also recorded as our first dealer in minerals.

From this time onward, the number of those interested in local mineralogy is multiplied. Among those more or less devoted to the study and collection of home specimens may be mentioned the names of Dr. Benj. N. Martin, Prof. D. S. Martin, J. W. Deems, L. Winslow, A. Woodward, and S. C. H. Bailey.

The monograph of the last-named collector, read before the Lyceum of Natural History, November, 1865, gives evidence of the rapid advance in mineralogical research. The writer is fond of noticing the associations of certain minerals, drawing interesting parallels between home and foreign groups of crystals.

Among the important specimens found by him were rhomboidal biotite, hexagonal crystals of molybdenite, fine garnet masses in a yellow schist, essonite, transparent white apatite, orthite, and handsome zeolitic minerals from Fourth Avenue. Rarest of all was what he believed to be graphic tellurium from a strange rock which seemed to be neither *in situ* nor a boulder, quite similar to the gangue of the Transylvanian mineral.

To Mr. Bailey the author is indebted for valuable suggestions when in the year 1871 he fell into the line of students of local mineralogy, on the object lesson plan.[1]

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[1] The author's taste for mineralogy was aroused when a lad of 13 years of age, by meeting with an engineer from Cornwall, England, who was about to take charge of the celebrated copper mine near Bristol, Ct., where he was then residing. The contents of the iron-bound chest

Among later collectors is Mr. Wm. E. Hidden, to whom our list is indebted for a series of our rarest minerals.

Mr. George F. Kunz has greatly helped in promoting the work among others, and to this end joined the author in taking steps for the formation of a mineralogical club. This society, formed in the spring of 1887, is in a state of gratifying prosperity, numbering nearly fifty members.

Other late collectors are Dr. J. J. Friedrich, and Mr. Wm. Niven. The latter gentleman has met with gratifying success in the addition of a number of important specimens to our catalogue.

Mineral Localities in New York County.

The first recorded locality resorted to by collectors was Corlear's Hook, a mile or more out of the city. This has been described as a great deposit of diluvial sand, pebbles and boulders or "alluvion," topped by a series of conical hills, fifteen or twenty feet in diameter. The bed was very deep, shafts having been sunk seventy to one hundred and fifty feet before reaching bed rock. Here was found the largest number and variety of rocks on the island.[1]

The largest boulder, some eighteen feet in length, came from the serpentine locality at Fifty-eighth Street, North River. From this was obtained asbestus and actinolite. Another boulder supplied epidote, carbonate of lime, indicolite, and an ore which was thought to contain nickel. Apatite and garnets were quite plentiful. One enterprising collector discovered oölite, another graphite, and another madrepore corals, fifty feet below the surface of the deposit.

More venturesome expeditions resulted in the finding of staurolite three and one-half miles from the city, on the Hudson (now about Fortieth Street). At four and one-half miles (Fifty-eighth to Sixty-third Streets) was the anthophyllite locality, which has ever been to mineralogists a spot of peculiar interest. Prof. John Torrey sent a specimen of the radiated mineral to Dr. Thomson, of Glasgow, by whom it was analyzed and named hydrous anthophyllite.

The gneiss quarries at Kip's Bay and Turtle Bay, from about Thirty-eighth to Forty-fourth Streets, East River, have been

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which accompanied the engineer, consisting of instruments and rare minerals from the old-world mines, were sufficient to entice the lad into so fascinating a department of science. His taste, however, became dormant for many years, until revived on his removal to this city, where opportunity favored his former habit of rambling and research.

[1] Bruce's Min. Journal, 1814.

worked for fully fifty years, and have finally disappeared. Some of the more interesting minerals obtained here by early and later collectors are galenite, pyrite, kyanite, stilbite, chabazite and harmotome. A few specimens of the last-named mineral contained cruciform crystals, some of which were fully an inch in length.

A few blocks to the westward, near Second Avenue, between Forty-fifth and Forty-sixth Streets, a locality was opened affording some of the best zeolites on the Island. Those were rescued by the writer from destruction one bright spring morning during his first expedition of the season. The strange prompting which led him thither is an experience never to be forgotten.

The blocks bounded by Sixth and Seventh Avenues, from Fifty-fourth Street to Central Park, included an interesting region.

West Fifty-eighth Street, near the Hudson, to about Sixty-third Street, is the celebrated serpentine and anthophyllite deposit, which is well known to mineralogists the world over. Boulders of the rock have been found far distant from the locality, some on Fourteenth Street and Third Avenue, at Corlear's Hook, and in South Brooklyn. Some years since an attempt was made to work up the material for commercial purposes. It proved too hard and refractory, and the experimenter was ruined financially in his effort.

The Harlem Tunnel at Ninety-sixth Street and Fourth Avenue was a locality of interest to collectors in the early days of railroad building. The various zeolites were here quite abundant. The improvements in 1871–3, including the widening of the tunnel, afforded opportunity for additional supplies, not only of the zeolites, but of other desirable material. Some of these, including the harmotomes discovered by the writer, have found their way into many of the chief cabinets of the land. Lately the veins appearing at the tunnel have been again opened at One Hundredth Street. Parallel veins have proved even more prolific, yielding the most abundant supplies of kyanite, tourmalines, and garnets ever obtained on the island. Thirty-four tourmalines were obtained from a quartz pocket by the writer, seventeen of which were terminated. The largest crystal, one inch in diameter and five inches in length, with good terminal planes, would be a fair companion piece to the fine Haddam tourmaline in the collection at Yale College.

From this point westward to Central Park, one of the most elevated sections of the island, the presence of interesting minerals is everywhere apparent. The focus of interest was struck, but only slightly, in grading Fifth Avenue at One Hundred and

Fifth Street. Here a bed of calcite yielded a few choice specimens of sphene, globular chlorite, the rarer zeolites, etc.

The region in Harlem about One Hundred and Twentieth Street, Fourth Avenue and westward, is an interesting one. It is the chief locality of a mineral formerly known as indicolite, now proving worthy of a new title.

Above the serpentine locality, the west side of the city has not proved of special importance to collectors. The laying out of Riverside Park afforded the writer good specimens of picture mica, in considerable quantity; also specimens of the new named mineral just alluded to.

Above Manhattanville is a moraine, affording a great variety of boulders and pebbles, similar to the Corlear's Hook "alluvion" of "olden time."

Washington Heights is proving a most interesting locality. A granite vein at Fort George has afforded many species not heretofore found in this locality, some of them being rare.

Towards the northern end of the island the beds of dolomite make their appearance. That near Inwood affords malacolite or white augite. The next deposit forms a beautiful knoll, the site of the palatial Seamen residence, with its classic archway at the entrance, built of the dolomite quarried on the spot.

The abandoned quarry (Thomson's) at One Hundred and Ninety-sixth Street was a noted resort for collectors in the early part of the century. Rutile, malacolite, pyrallolite, phlogopite, brown tourmalines, and necronite were the principal minerals here obtainable.

The Government improvements along the Harlem will doubtless renew opportunities for research among the dolomite deposits.

East of the Harlem the beds of dolomite are numerous. That nearest to the Madison Avenue bridge in Mott Haven, referred to by Prof. R. P. Stevens in a paper read before this Society,[1] has since been removed. Its northwestern extremity yielded a pink variety of dolomite which awakened considerable interest and discussion when first presented before the Academy. (Transactions, Vol. VI., pp. 39 and 91.)

In the dolomite are occasionally found splendent and highly modified crystals of pyrite.

In the accompanying list is a description of one secured by the writer which has been pronounced one of the rarest found on the continent.

In the district lately added to the city, east of the Harlem,

[1] Published in Annals of the Lyceum, Vol. viii.

the excavators are everywhere busy, and opportunities for collectors are multiplying rapidly. Those interested in mineralogy are eagerly awaiting what the future shall bring forth.

Number of Species.

The lists of Robinson and Cozzens numbered some thirty-five minerals. That of Mr. Bailey in 1865 embraced about forty-five titles.

What is deemed a complete list to date is herein presented.

Some of the less important varieties are omitted, and about one hundred important names are placed on record—an addition of seventy in forty-five years. Of this last seventy-five are species.

The majority of the specimens described are from the author's collection.

Perhaps no city on the globe (with the possible exception of Philadelphia) can produce so extended a catalogue. But the inference is not to be drawn that the quantity of mineral specimens is indicated by the variety. Our locality is far behind many others in this respect. Specimens are not so plentiful as to be numbered among the chief bric-a-brac of the homes of our citizens, as in the copper regions of Lake Superior. Nor can a visitor sit down before any mass of rock fragments, as at Franklin, N. J., and in the space of an hour collect a load of interesting trophies.

Our blasting operations are for the most part superficial—seldom deep enough to reach interesting material. Nor have quarrymen any special inducement to pursue veins and open pockets, which may be suggested or indicated at the surface.

Authorities Quoted.

Issachar Cozzens ("Geology and Min. of N. Y. Island").	I. C.
Fred. S. Cozzens.	
J. W. Nuttall.	
S. C. Robinson, M.D., Catalogue of American Minerals.	Rob.
J. W. Webster.	J. W. W.
J. D. Dana.	
L. D. Gale, M.D.	
S. C. H. Bailey.	S. C. H. B.
W. E. Hidden.	W. E. H.

CLASSIFIED LIST.

(Arranged according to Dana's Manual of 1887. Species recognized by Dana in black face type; varieties in italics.)

ACIDIC DIVISION.

SULPHUR GROUP.

Molybdenite. In well-formed crystals, E. 38th street (S.C. H.B.).

Quite plentifully in excavations for Columbia College buildings, Fourth avenue and 49th street.

Sparingly at Madison avenue and 120th street.

Molybdite (yellow oxide of molybdenum). E. 42d street and other localities (J. W. Deems).

Tellurium (Graphic) ? Manhattanville (S.C.H.B.).

CARBON GROUP.

Graphite. In vein of calcite in boulder. Corlear's Hook, 1825 (Robinson's Min.). In hexagonal crystals, in feldspar, "near the city," 1825 (Rob.).

BASIC DIVISION.

COPPER.

Chalcopyrite. Present with pyrite in dolomite beds of Morrisania and elsewhere, massive specimen, Fourth ave., near 115th street.

Incrustation on gneiss, 135th street, bet. Seventh and Eighth avenues.

Brilliant scales in veins in dolomite, Harlem Canal.

Bornite (Erubescite) (variegated copper pyrites). Fort George (Wm. Niven, 1888).

Bournonite. Fourth avenue, 80th street (W. E. Hidden).

Malachite. In thin incrustations or aggregations of scales in fissures of gneiss, in color a rich emerald green, 56th street, Sixth and Seventh avenues; 117th street, bet. Madison and Fourth avenues; Fifth avenue and 100th street; 100th street and Lexington avenue; Fort George (Tenth avenue and 195th street).

Azurite. Similar in character to the above and found at most of the same localities.

LEAD.

Galenite. A few modified cubic crystals obtained at the Turtle Bay quarry, 43d street, E. R.

Small crystals from New Aqueduct Shaft, No. 27 (A. P. Bjerregard, 1887).

ZINC.

Sphalerite. In small amorphous masses, associated with pyrite, 45th street and Second avenue.

In larger masses in dolomite, St. Ann's avenue and 145th street.

TITANIUM.

Rutile. In slender prisms of a blood-red color, sometimes *fasciated,* at other times *reticulated,* noticeable in rocks of region embraced between Third and Fifth avenues from 100th to 105th streets.

Large stout prism with interesting features found by Mr. A. Woodward, Central Avenue Quarry.

In flat prisms, of a bluish irised tint, resembling sections of a watch-spring, found in veins of calcite in dolomite, St. Ann's avenue and 145th street.

In stout prisms of a dark color, Fort George.

Sparingly, Eighth avenue and 104th street.

In finely terminated prisms in dolomite, Harlem Canal.

In incrustations or sheets, resembling copper, in crevices of albite, Fifth avenue and 104th street.

URANIUM.

Uraninite (?) 175th street and Eleventh avenue.

Autunite(?). Reported as having been discovered at Fort George.

IRON.

Pyrite. In brilliant and perfect octahedral crystals, Kip's Bay Quarries (S.C.H.B.).

In cubes with curved faces, the crystals often aggregated in masses, 43d street, E. R.

In drusy cubic crystals with brilliant lustre on stilbite, 45th street and Second avenue.

In flattened cubes between leaves of muscovite (J. J. Friedrich, M.D.), E. 43d street.

Globular, one specimen, also a pentagonal dodecahedron. 45th street and Second avenue.

Fine examples of the cube with octahedral and trapezohedral planes, some of about one inch in diameter, were found at the

dolomite bed, St. Ann's avenue, 145th street. The faces of the trapezohedron are striated, parallel to the octahedral faces. The same locality yielded massive pyrite.

Brilliant, finely modified crystals in dolomite, Harlem Canal (W.N.).

Pyrite penetrating tourmaline, Jumel Grounds, Washington Heights. Also at 172d street and Tenth avenue.

Massive in dolomite, Harlem and Kingsbridge.

Marcasite. In reniform and globular masses, with traces of crystallization. Excavations for addition to Met. Museum of Art, 1886. With calcite and quartz, Aqueduct shaft No. 22.

Pyrrhotite. Fort George.

Menaccanite. In thin brilliant plates, occasionally showing crystal edges and angles. 56th street, Sixth and Seventh avenues; Fifth avenue, 104th street; Lexington avenue and 101st street; Morrisania.

Washingtonite. The plates sometimes an inch across, 56th street, Sixth and Seventh avenues. (D. S. Martin.)

Crichtonite (?) In smoky quartz. Found by W. H. Pease in the drift (I. C.). This was very probably menaccanite.

Magnetite. In seams of quartz in gneiss, 100th street, Lexington avenue; Jumel Grounds, Washington Heights; 56th street, Sixth and Seventh avenues.

Crystallized in lamellar and radiated forms, between leaves of muscovite, Riverside Park and elsewhere.

Chromite. Octahedral crystals in serpentine, 60th street, North River.

Limonite. *Bog iron ore,* in large beds about the island (Rob.). In low grounds east of Eighth avenue, and north of Sixth street to 32d street.

In masses often iridescent, east bank of Harlem River.

In globular forms resembling shot, 55th street, Sixth and Seventh avenues, and elsewhere.

Columbite.[1] First discovery of this mineral on the island in the summer of 1887, at the granite vein, Fort George.

Vivianite. Associated with stilbite and epidote in fissures in gneiss. Harlem (J. W. Webster).

Siderite. In perfect rhombohedral forms (S. C. H. B.), 57th

[1] In collection of Mr. George F. Kunz. Described by him in Transa tions of the Academy.

street. In masses of rhombohedral crystals of dull color and lustre, 59th street, Eighth avenue. In reticulated crusts, light gray color, 44th and 45th streets, Second avenue.

Sphærosiderite. In globes and lenticular forms, very many of which are twinned, Fourth avenue, 85th street. Also in globes one-half inch in diameter, 45th street, Second avenue.

MANGANESE.

Manganese (Bog). Near the city. Old record.

Dendritic Wad on orthoclase. High Bridge.

Triphylite (?). Central Park, near Seventh ave. (S.C. H. B.).

Alluadite (?) Fourth avenue (S. C. H. B.).

ALUMINIUM.

Chrysoberyl. In small crystals on orthoclase, High Bridge (Niven, Hidden).

Kalinite. In whitish lumps and efflorescence on rock surfaces, especially just after a rain.

East 59th street, near East River; East 42d street, near Tunnel; 160th street, Eleventh avenue; *yellow variety*, 68th street, Eighth and Ninth avenues.

Copper Alum. Precipitating copper on a knife blade in a weak solution (W. E. H.).

CERIUM, YTTRIUM, ERBIUM, LANTHANUM, DIDYMIUM. YTTROCERITE.

Fluocerite. One specimen, Fourth avenue and 90th street (W. E. H.).

Monazite. One or two crystals of remarkably fine form, Washington Heights, 1888 (Niven, Hidden).

Xenotime. Described by W. E. Hidden, who found a single crystal in 1872 at Tenth avenue and 155th street, showing planes 1, I, 3-3.

Several crystals found in the spring of 1888 by Mr. Niven had long, square prisms, with bright terminal faces, and were identified as xenotime by Mr. Hidden. These were less than $\frac{1}{8}$ inch in diameter, and about $\frac{1}{4}$ inch in length. From 155th street and Tenth avenue.

CALCIUM.

Fluorite. In yellow and blue cubes $\frac{1}{4}$ inch in diameter, on gneiss at the Hell Gate excavations (cited by W. E. Hidden).

Gypsum. *Selenite* crystals on a boulder. Harlem Common (I. C.).

Apatite. Crystallized and amorphous in feldspar, Corlear's Hook (Rob.).

In greenish prisms in granite "near the city" (Rob.).

A few fine crystals, associated with beautifully crystallized mica and octahedral pyrite, Kip's Bay Quarries (S. C. H. B.).

Broken crystals of rich green color, 42d street, Second and Third avenues.

Beautiful deep green crystals of small size, Washington Heights.

Crystal, six inches in length, injured in extraction from gangue, 122d street, near Riverside Drive.

Transparent white crystals, with albite and chlorite, similar to specimens from Piedmont, E. 38th street (S. C. H. B.).

Microlite. Small octahedron in oligoclase, 39th street, Sixth and Seventh avenues (W. E. H.).

Calcite. In veins in serpentine, 58th street and Tenth avenue.

In veins in dolomite, St. Ann's avenue and 145th street.

Crystallized, in thin, white rhombic plates, aggregated in a series of cells; beautiful specimens. Harlem Tunnel, 1874.

Dog-tooth spar, sparingly, St. Ann's avenue quarry.

Brown calcite (?). A deposit of this variety was reached some years since in grading Fifth avenue at 105th street. Unfortunately, the excavations were shallow, affording collectors a glimpse only of a choice store of interesting minerals imbedded in the spar. These were rutile, sphene, globular chlorite, garnets, etc.

Oolite, found by F. S. Cozzens, Corlear's Hook.

Aragonite. In radiated groups of *yellow* prisms several inches in length, Fourth avenue and 96th street (S.C.H.B.).

White, in veins in dolomite, a fibrous variety, the fibres lying transversely, St. Ann's avenue and 145th street.

Flos ferri, Fourth avenue, 1874.

Dolomite. New York county is situated on the noted line of dolomite beds extending from Vermont to N. Carolina. Perhaps a dozen of these deposits are within the limits of the county. The most southerly beds of importance are at Lexington avenue and 120th street; Madison avenue and 135th street; Mott Haven, near Madison avenue bridge.

Good crystallized specimens of the mineral are rarely found

in the vicinity, nor has the author succeeded in finding anything of importance nearer than Pleasantville, Westchester Co.

The dolomite deposits contain pyrite, chalcopyrite, rutile, chlorite, ripidolite, tremolite, brown tourmalines, quartz, malacolite, etc. Nearly fifty years ago, the Kingsbridge quarries were much resorted to by collectors.

Pink dolomite. This beautiful variety, first found by Mr. A. P. Bjerregard, was exhibited at the N. Y. Academy of Sciences during the spring of 1887, and awakened much interest among collectors. Obtained from the dolomite bed at Mott Haven near Madison avenue bridge.

Hydrodolomite. Morrisania, Kingsbridge.

HYDROGEN.

Water (*Hydrogen Oxide*).

Chalybeate Water. A spring containing the above water situated on the 'Incleberg' (Murray Hill) grounds of Mr. Coster, described by Dr. S. L. Mitchill in Bruce's *Mineralogical Journal*, 1814.

A well of the same character is noted in list of I. Cozzens. This was located on Eighth avenue near 28th street.

SILICA AND THE SILICATES.

Silica.

Quartz. Crystals in granite, Old Glass House Point (I.C.).

Crystals in granite, Bellevue (I.C.).

A few crystals nearly one inch in diameter and two inches long, found at the orthite locality, Broadway and 56th street.

Others of smaller size, 56th street, Sixth and Seventh avenues.

Specimens showing terminal faces only, 138th street and Brook avenue.

Crystals of unusual interest, for this locality, in collection of Mr. A. Woodward.

In thin plates of aggregated pyramidal planes, interlaminated with dolomite, some specimens rather showy, many yellow or brownish, and some iridescent, Dolomite Quarry, Central avenue.

Milky Quartz. In masses distributed through the gneiss, the surface often glaciated. Near Reservoir, Washington Heights.

In broad vein in gneiss, much of it laminated. West Morningside avenue.

In other localities on First, Sixth and Tenth avenues.

Smoky (Cairngorm stone), associated with kyanite, Lexington avenue and 101st street.

Crystals, also massive, Fort George (W. Niven).

Small crystals, some doubly terminated mounted on pedestals of milky quartz, in dolomite beds, Harlem Canal.

Rose, in granite on the Island (Rob.); inferior specimens under Harlem R. R. track at 122d street (L. D. Gale, 1838).

Also found at Morrisania.

Amethyst. Limpid quartz prisms with pyramidal caps of amethyst, similar to specimens from Transylvania; some of the caps were $\frac{3}{4}$ inch in diameter and were removable, 59th street, Sixth and Seventh avenues.

A few pale specimens obtained from a bed of quartz at 117th street near Fourth avenue. Possibly allied to the rose quartz of Dr. L. D. Gale at 122d street.

Ferruginous. Found everywhere, especially abundant in the drift at Manhattanville.

Striped Jasper, often called *Agate.* In large and small boulders deposited from the drift.

Jasper, red, brown, green, and blue. Along Harlem river.

Basanite or Touchstone. Drift of Harlem.

Chert, a yellowish jasper-like rock from the drift. Gansevoort street.

Silicates.

Anhydrous—Bisilicates.

Wollastonite. Fort George.

Pyroxene, Augite. Group of fine hexagonal crystals with shimmering surfaces, in color a dull leek green, 56th street, Sixth and Seventh avenues.

Large specimen in wall, probably a "wandering stone," 102d street, Madison avenue.

Malacolite (white augite). In good crystals often doubly terminated. At the beds of dolomite near Inwood and Thompson's Quarry, 196th street.

Pyrallolite, in dolomite, name substituted for rhoetizite (Nuttall). Kingsbridge.

Coccolite, along Bronx river (Rob.).

Hypersthene. Observed occasionally in boulders.

Amphibole, Hornblende. In rich black bladed masses, 56th street, Sixth and Seventh avenues.

In crystallized masses, Fifth avenue, 100th street.

Hornblende as a constituent of hornblendic gneiss and slate, abundant. It is often associated with epidote.

Tremolite. This mineral was formerly obtained at Thompson's Quarry, 196th street.

At present the principal source is in boulders, in stone walls and elsewhere.

The east bank of the Harlem has furnished fragments of dolomite showing fair specimens.

Specimens also appear at the quarry on Central avenue.

Actinolite. Good specimens from boulders used in macadamizing, Seventh avenue at 130th street.

At the anthophyllite locality, 63d street, Twelfth avenue.

Anthophyllite (hydrous), analyzed and named by Dr. Wm. Thomson of Glasgow. By Prof. J. D. Dana it is considered an altered asbestiform tremolite.

Abundant in veins in serpentine, W. 60th street.

Asbestus, at the anthophyllite locality.

A white variety near Spuyten Duyvil.

Amianthus (silky asbestos). In serpentine boulders, Amity street (I. C.) and West 58th street.

Mountain Cork, in boulders, Amity street (I. C.).

Byssolite, a green, silky variety associated with epidote like that from Italy, 55th street, cor. Broadway.

Fibrous Hornblende, 43d street, Second avenue.

Beryl. In small yellowish-green crystals in oligoclase, Tenth avenue near Hebrew Orphan Asylum.

Aquamarine, a mass of the transparent sea-green variety of beryl known by this name has yielded a lapidary several interesting gem-stones. From Washington Heights.

Large finely shaped crystals from granite vein in gneiss, Fort George. Collection of G. F. Kunz.

White and also a very light green variety of opaque beryls, found in a granitic vein, the feldspar of which was changing to kaolin; First avenue above 42d street.

The early writers on New York minerals did not hesitate to call the deep colored beryls emeralds. Robinson speaks of the island as one of three localities in the Union affording emeralds, the others were Haddam, Ct., and Paris, Me.

Anhydrous—Unisilicates.

Garnets. Garnets are observable in very many localities throughout the county. They are usually opaque and of a dark-red color. Fine specimens are not common.

A fine deposit of small garnets in a cream-colored schist was obtained some years since by Mr. S. C. H. Bailey, at 23d street, cor. Broadway. Larger ones finely formed, E. 42d street.

Among other deposits noticed by the writer are, 50th street, Lexington avenue; 45th street, Second avenue; 59th street, Sixth and Seventh avenues; 118th street near Lenox avenue; Hell Gate excavations.

The finest crystal in color and perfection of faces and angles, size three inches in diameter, appeared in a heap of stone deposited some years since in front of the *Times* office. Unfortunately, it was injured in process of extraction from the gangue. It has been partially restored. The original locality was probably near 56th street and Sixth avenue.

A large garnet with striated faces, nearly four inches in diameter, 22 faces intact, in color a dull darkish brown, from Brook avenue, near 144th street.

A similar specimen five inches in diameter appeared in the rock at the same locality, but in too frail a condition to permit removal.

A peculiar *light red* variety appeared at the kyanite locality associated with the kyanite, occasionally in masses nearly ten inches square, 101st street, Lexington avenue.

A *lamellar* variety plentiful at Lenox avenue, 119th street.

From this point eastward and northward to Mt. Morris square, pockets and veins of garnets abound in greater number than in any portion of the city or county. The rocky heights of the park are thickly studded with weathered crystals. The find of good cabinet specimens is, unfortunately, quite limited.

Combination crystals of the dodecahedral and trapezohedral forms, in color dark red, size ¾ inch in diameter, E. 43d street, E. R.

Under the head of extraordinary *compound* crystals, our city has furnished to science the largest and most interesting garnet yet discovered on the continent. The specimen is in excellent condition, with sharp angles and smooth faces, size 6 inches in diameter. Color dull red, spotted occasionally with chlorite. It weighs nine pounds ten ounces (Cabinet of G. F. Kunz).

An unusually abundant deposit of the above-described form of garnets was opened in the summer of 1888, at 65th street and Boulevard.

Essonite. Cinnamon garnet, cinnamon stone. In oligoclase, at Tenth avenue, 135th street.

Grossularite,

Topazolite, yellow garnet, and

Melanite, black garnet, found in cavities in boulders of metamorphosed sandstone, Manhattanville.

Zircon, in granite. Washington Heights (W. E. H.).

Idocrase [?] (Rev. E. Seymour). Dull green crystals in metamorphosed sandstone.

Epidote. Epidote rock is occasionally noticed throughout New York County. It is generally associated with hornblendic gneiss. A prominent locality is now covered by the Navarro Flats, 59th street, Sixth and Seventh avenues.

Abundant also at 100th street, Lexington avenue, Fort George and elsewhere.

Granular massive, 37th street, between Third and Lexington avenues, and elsewhere (D. S. Martin).

Bright green crystallized specimens have been obtained on 57th street, West of Ninth avenue; Lexington avenue, 44th street; 56th street, Sixth and Seventh avenues; 55th street, Sixth and Seventh avenues; Harlem Tunnel.

Abundant at railroad cut, Spuyten Duyvil.

Crystal $1\frac{1}{2}$ inches in length, good color, 59th street, Sixth and Seventh avenues.

Remarkably good prism for this locality, 1 inch long, $\frac{1}{3}$ inch in diameter, Fort George (Wm. Niven).

Orthite. One of the most notable minerals about New York, embracing in its composition the rare elements, Lanthanum, Didymium, Cerium, and Yttrium.

The crystals are dark reddish brown to black in color, of a pitchy lustre, often bent and twisted, set in white oligoclase, which is usually stained red in the vicinity of the crystal. Found at one locality only, 56th street, near S. E. corner Broadway.

Iolite. First found by Wm. Niven, but identified and described by W. E. Hidden. Planes O, 1, $i-\overline{3}$ (?), and on the other prism, $O \wedge 1 = 133°$ (132° 12′, Dana). The specimen is divided into basal sections. Diameters $1 \times 1\frac{1}{2}$ inches. Color grayish-green. Hardness 4. From Fort George.

Pinite. An altered iolite from the same locality.

Mica Group.

Muscovite. In large hexagonal crystals, twelve or fifteen inches in length. Found in excavating site for car-stables, Sixth avenue and 45th street.

Good crystals, one nearly the size of the above, Tenth avenue and 130th street.

Finely shaped crystals, 56th street, Sixth and Seventh

avenues; 45th street and Second avenue; 43d street, Second and Third avenues.

Also in dolomite at junction with gneiss, Brook avenue and 145th street.

Good crystals, Riverside Park.

Masses of small crystals, 63d street and Broadway.

"*Spear Mica,*" 43d street, Second and Third avenues.

Prismatic, do.

"*Picture*" mica, excellent specimens, some 12 inches in length, Riverside Drive and 120th street.

Striped and banded, parallel to sides of crystals, in some cases a rich blue (S. C. H. Bailey), 45th street and Second avenue; 40th street, Second and Third avenues, and various localities.

White or silvery (perhaps sericite or a similar variety), 96th street and Third avenue; 101st street and Lexington avenue; 126th street and St. Nicholas avenue.

Green, 93d street and Ninth avenue; 101st street and Lexington avenue; Convent Ground, Eighth avenue and 128th street; Fort George, and elsewhere.

Golden-yellow, in small leaves, in a very white oligoclase, found in paving-material, Boulevard at 63d street.

Phlogopite. Generally in small scales. Good crystalline shapes are quite rare. Color, a handsome light-brown. 145th street and St. Ann's avenue, Kingsbridge Quarries; very light color, Quarry, Central avenue.

Biotite. Good crystals, 3 inches long, usually distorted rhombic prisms, Seventh avenue and 135th street.

Handsome rhomboidal specimens, like those from Brevig, Norway (S. C. H. Bailey), 57th street.

Pocket of rich black crystal masses, 56th street, between Sixth and Seventh avenues.

Quite abundant in vicinity of Brook avenue and 138th street.

Scapolite Group.

Scapolite. Abundant in the localities below named. Good crystals are rare and of so frail a nature as barely to permit removal. Lexington avenue and 100th street, Fifth avenue and 100th street; also of a firmer quality, Fort George.

Feldspar Group.

Oligoclase. Found in many localities where blasting operations occur.

In laminated plates showing striations on the edges. Color, white, light green, and bluish.

Large specimens of a white color quite abundant at 119th street and Lenox avenue.

In handsome cleavage plates at 92d street and Fourth avenue.

Light green variety at Riverside Park.

Dark green variety at New Aqueduct Shaft No. 27, Washington Heights.

Blue variety at Harlem.

White crystals at various localities.

Light green crystals, large size, at 46th street and Second avenue.

Albite. Quite abundant in region between Third and Fifth avenues, from 93d to 101st streets.

Crystallized specimens at Fifth avenue and 100th street, Lexington avenue and 100th street.

Cleavelandite. In boulders, Corlear's Hook, and near city, 40th street, Hudson River (I. C.).

Orthoclase. This mineral, as one of the three constituents of the prevailing rock of the county—gneiss, is everywhere abundant. Conspicuous masses are, however, not so common, and the collector needs to avail himself of good opportunities for securing fine specimens of either the laminated plates or crystallized fragments. The feldspar varies in color from a dull white through different shades of yellow and flesh-color, to a bright red. Some of the localities were the following:

In broad flesh-colored plates with highly lustrous surfaces, 96th street and Fourth avenue; 56th street, Sixth and Seventh avenues.

Brownish gray variety resembling perthite, 43d street, Second and Third avenues.

Red, Fourth avenue and 120th street.

Cream-colored, 46th street and Second avenue.

White, 94th street and Third avenue.

White, slightly opaline, Harlem Tunnel.

Crystals are usually of the primitive rhombic form found lining fissures in gneiss.

Good examples were obtained at 96th street and Fourth avenues, 56th street and Sixth and Seventh avenues, and Lexington avenue and 44th street.

More highly modified forms and larger in size usually appear in granite veins. A few handsome specimens (in collection of Geo. F. Kunz), among which was a remarkable twinned crystal, were found at Fort George; also at 43d street and First avenue. At the latter locality the feldspar of the granite vein was changing to kaolin. The mica and beryls present partook of the

change. The orthoclase crystals were of large size, some six by four inches. Crystals of less size appear in a porphyritic rock on the east bank of the Harlem River above McComb's bridge (L. Winslow).

Remarkably fine groups of modified crystals coated with albite (G. J. Brush) were secured at 96th street near Third avenue.

Necronite (fetid feldspar), of a bluish white color, in tabular masses in limestone, Thompson's quarry, Kingsbridge.

Adularia. Corlear's Hook (I. C.). In serrated columns of aggregated crystals, Fourth avenue and 90th street.

Glassy feldspar (G. J. Brush). 57th street and Sixth and Seventh avenues. In rocks at Bellevue (I. C.). In quartz veins in limestone at Corlear's Hook (Rob.) (I. C.).

Kaolin. Old road three mile stone (I. C.). Deposit of three colors, red, yellow, white, 70th street and Fourth avenue. Vein in Central Park and vicinity, Eighth avenue and 104th street.

Anhydrous—Subsilicates.

Tourmaline. In granite. McGowan's Pass (I. Cozzens). Good specimens of the black variety set in pink orthoclase, 80th street and Fourth avenue.

Large masses showing no crystal faces, and readily crumbling into what might be taken for black sand, Morningside Park, 122d street.

Brilliant prisms of moderate size set in a bluish oligoclase. Also crystals slightly iridescent, Tenth avenue and 172d street.

Small, but brilliant doubly terminated crystals, associated with clear pink garnets, affording an interesting exhibit under a magnifying glass, First avenue and 45th street.

Massive tourmaline, with pyrite, filling fissures, Jumel grounds, Washington Heights.

Perhaps the most remarkable deposit of tourmalines in the island, on record, was discovered by the author in the year 1885, in a vein of gray quartz traversing gneiss, parallel to the stilbite veins near the Fourth avenue tunnel, above 96th street. Many of the finest crystals were obtained by fracturing the quartz, which yielded readily to the chisel. Nearly twenty fine terminated crystals were among the number obtained at this point. The largest crystal was 5 inches in length, $1\frac{1}{4}$ to $1\frac{1}{2}$ in. in diameter, with good terminal planes.

With the tourmalines appeared the choice garnets above alluded to. Other minerals were green mica, sericite (?) smoky quartz, epidote, albite, and a very red orthoclase.

Radiated groupings (termed "sunbursts" by the Irish laborers). 56th street, between Broadway and Seventh avenue.

Similar specimens on quartz. New Aqueduct shaft No. 28.

Very handsome specimens (collection of G. F. Kunz). Washington Heights, 1888.

Groups of radiated crystals, increasing in size as they progress from point of radiation. Washington Heights, near Inwood.

In profusion on the walls of a fissure in gneiss. Small radiated groups of acicular crystals. 122d street and Madison avenue.

Brown Tourmaline. Thompson's Quarry, 196th street; Harlem Canal.

Green prisms, small and slender in size, noticed in association with the brown variety (W. E. H.). Harlem Canal.

Fibrolite. In whitish fibrous blades, at 117th street and Fourth avenue.

Has been noticed also at Washington Heights.

At 52d street and Madison avenue (J. D. Dana).

Dumortierite. (Determination by J. D. Dana, and by J. S. Diller).

One of the most interesting minerals of the island. Often thought to be a blue variety of tourmaline; probably the *indicolite* of Prof. J. W. Webster.

In acicular crystals of a beautiful ultramarine blue color, aggregated in fasces or tufts resembling clippings of hair. In my possession are the largest crystals yet discovered; perhaps $\frac{1}{3}$ inch in diameter. The mineral is sparingly distributed through a lode of red granite extending southeastwardly from Fourth avenue at 123d street to Madison avenue at 116th street.

Noticed by S. C. H. Bailey, at Kip's Bay, 1865. The same mineral I have also discovered in white oligoclase near the upper end of Riverside Park.

Also reported to have been found on Tenth avenue at 130th street.

Kyanite. Sparingly at the Turtle Bay quarries.

In excavations for new buildings, Columbia College grounds, 49th street and Madison avenue. Previously found at same locality by F. S. Cozzens (I. C.).

In excavations at 42d street and Park avenue, opposite the Grand Central Depot, small pale blades, so abundant in the rock

as to lead to the proposed name, "kyanite-schist" (D. S. Martin).

Green and bluish varieties, probably the richest deposit ever found in the city, at 101st street and Third and Lexington avenues, obtained during the year 1885. The kyanite vein is parallel to the stilbite and other veins running from north-east to south-west, their most productive point being at the Harlem tunnel.

Between the blades of kyanite appeared a deep-hued smoky quartz, also garnets and scapolite.

Sparingly at Manhattan avenue and 103d street.

Datolite. In trap boulders. Old record.

Sphene. In small rhomboidal prisms with dihedral summits of a light dove-color (silico-calcareous oxide of titanium of Cozzens), in limestone. Kingsbridge (I. C.).

In light green crystals at the brown calcite locality at 105th street and Fifth avenue.

Also at Lexington avenue and 100th street, and 96th street and Third avenue.

Larger and finer crystals of the same color obtained (1887) at Fort George.

A chocolate-colored variety has been noticed along the Harlem River.

Staurolite. In terminated prisms, "three miles from the city, near the North River" (Rob.). Also at Fort George.

Hydrous Silicates—General Section.

Laumontite. Sparingly at Fifth avenue and 104th st.

Apophyllite. In trap boulder, Manhattanville (S. C. H. B.).

Allophane. In silvery-white incrustations on boulders (S. C. H. B., and the author).

Zeolite Section.

Thomsonite. Reported to have been found with the natrolite and laumontite at Fifth avenue and 105th street.

Natrolite. In delicate snow-white globes of radiated acicular crystals, similar to specimens from Bergen Hill.

Associated with chlorite, sphene and rutile at the brown calcite locality, Fifth avenue and 104th street.

Analcite. A few crystals at same locality.

Chabazite. In yellow and chocolate-brown crystals $\frac{1}{6}$ to $\frac{1}{8}$ inch in diameter, Fourth avenue and 96th street.

Ochery yellow. Large crystals, $\frac{3}{4}$ inch in diameter, also, violet and fine yellow varieties, 45th and 46th streets and First and Second avenues.

Reddish-brown crystals, 43d street, E. R.

Phacolite. Three specimens of this variety of chabazite, showing well-defined crystals, one yellow, the others brown, appeared at 43d street, E. R.

Harmotome. This, one of our most appreciated local minerals, was discovered by the writer during the Harlem railroad improvements in the year 1871. The crystals (compound), averaging one-half an inch in length, were of two colors, yellow and brown.

Some of the specimens were of remarkable beauty, excelled by none perhaps in the United States. They have found their way into many of the most important collections of the country.

A deep cinnamon colored variety appeared at 43d street, E. R. Here the cruciform crystals were occasionally observed. Some of these were one inch in length.

These are the only localities in the city where this mineral was obtained. The writer has added to his collection further specimens from Tarrytown, some of which are white, others light cinnamon, red and pearl gray in color.

Heulandite. Abundant at the Fourth avenue excavations, 1872. Also at 43d street, E. R. A cream-colored variety at 46th street and Second avenue.

Stilbite. Seven localities on New York island have yielded this interesting zeolite, chief of which is Harlem Tunnel and vicinity, where the mineral, associated with heulandite, harmotome, and chabazite, appeared in a series of pockets and vein, running northeastward from Fourth avenue to 102d street near Lexington avenue. The stilbite, usually of a honey-yellow color, appeared in *columnar*, *scopiform*, *sheaf-like*, and *radiated* masses, but rarely, as at Bergen Hill, in lamellar sections of crystals. Some of the globular groups approached a bright red in color, affording a pleasing contrast to the yellow hue of simpler forms adjacent. Among radiated forms one specimen is nearly fifteen inches square, containing twenty-six rosettes. At 45th street, between First and Second avenues, a second prolific locality afforded plates of stilbite two feet square.

Many interesting specimens were, in the early spring of the year 1875, rescued by the writer just as the laborers' carts were about removing them to barges on the East River for transportation to distant points. Among interesting specimens were columnar forms with highly polished summits, others sprinkled with drusy pyrite, and masses of the mineral presenting cavities lined with chalybite.

Large rosettes, of a dull yellow color, four inches in diameter, appeared at East 42d street.

A *white* variety at Tenth avenue and 122d street.

Additional localities, E. 43d street, First avenue and 63d street, Ninth avenue and 63d street, Eighth avenue and 108th street.

Margarophyllite Section.

Talc. In white and yellow scales, attracting the gold-seekers, 60th street, N. R. (P. C.). Also found at Bellevue. Cream-colored, near 60th street and Tenth avenue (D. S. Martin).

Serpentine. An extensive bed of serpentine lies between the Hudson river and Tenth avenue, from 63d to 58th streets. It is usually of an olive-green color, at times nearly black. Intermixed with calcite, so as to present a mottled aspect, it is termed *ophiolite*. Clouded and veined specimens are known as *verde antique*.

Precious serpentine, from the dolomite bed, Lexington avenue and 123d street.

Chrysotile, fibres coarse and rather brittle, in the serpentine, W. 58th street (S. C. H. B.).

Marmolite, with serpentine and anthophyllite, 63d street, near Eleventh avenue (D. S. Martin).

Metaxite (?). A curious radiated mineral of a yellowish-green color, regarded by Prof. G. W. Brush as near the above, obtained by the author at Fourth avenue and 117th street.

Hydromica Group.

Sericite (?). Supposed to be the proper name for a whitish or yellow-white mica abundant in the neighborhood of 100th street and Lexington avenue, and 96th street and Third avenue.

Chlorite Group.

Chlorite. In *hexagonal plates*, aggregated in *globes* in brown spar. Fifth avenue and 104th street.

In *laminated masses*. Manhattan avenue and 104th street, also at 55th street, Sixth and Seventh avenues.

Pulverulent. From sewer excavations. 146th street and St. Ann's avenue.

Lining seams in gneiss. 56th street, Sixth and Seventh avenues. Fifth avenue, vicinity of 100th street.

Ripidolite. Very abundant in *layers* above bed of dolomite. Central avenue Quarry.

Vermiculite. Reported as found at Fort George.

Jefferisite. Brownish and dull greenish-gray laminæ lining cavities and fissures in gneiss. Vicinity of Fifth avenue and 100th street. Sparingly at Ninth avenue and 60th street. Also found at the various beds of dolomite.

ALPHABETICAL LIST.

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May 14, 1888.

STATED MEETING.

Mineralogical Section.

The President, PROF. J. S. NEWBERRY, in the chair.

Forty-one persons present.

The SECRETARY read a list of Accessions to the Library for the week ending May 14, prepared by the Librarian.

The PRESIDENT announced the death of Dr. Gerhard vom Rath.

The PRESIDENT stated that a letter had been received from Sir Henry Roscoe, accepting his election as an honorary member.

The PRESIDENT yielded the chair to the Chairman of the Mineralogical Section.

Section of Mineralogy.

First meeting; with the *New York Mineralogical Club* present.

The Chairman, MR. GEORGE F. KUNZ, presiding.

In the absence of the Secretary, MR. A. L. EWING was elected Temporary Secretary.

The minutes of the meeting of organization, April 16, 1888, were read and approved.

MR. GEORGE F. KUNZ read a paper on

PRECIOUS STONES; TEN YEARS' PROGRESS IN THEIR STUDY AND DISCOVERY.

(Illustrated with lantern views.)

Remarks were made by MR. W. E. HIDDEN, relating to the origin of the diamond, by PRESIDENT NEWBERRY, and by the author of the paper.

The PRESIDENT of the ACADEMY resumed the chair, and the Academy adjourned.

May 21, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Forty-three persons present.

The Librarian, DR. N. L. BRITTON, read a list of Accessions to the Library for the past week.

On motion of the LIBRARIAN it was voted that the thanks of the Academy be sent to Mr. Howard Shriver, in return for a donation of books.

PROF. D. S. MARTIN and the PRESIDENT spoke of the recent decease of two eminent archæologists whose names had long been associated, E. G. SQUIER and E. H. DAVIS.

PROF. W. LE CONTE STEVENS referred to the work of the Brooklyn Institute, and, as an officer of the institution, he extended to the members of the Academy an invitation to attend its meetings.

MR. WILLIAM E. HIDDEN announced the discovery, in Mr. Niven's collections from New York Island, of the following minerals new to the locality :—chrysoberyl, a fairly good crystal, lying in feldspar ; zircon (?), showing the unit and secondary prisms, unit pyramid, and the common zirconoid (3—3) ; monazite, having the characteristic monoclinic form and basal cleavage, but with density of 5.5, (commonly 5.1 to 5.3) ; autunite, in bright, light-green micaceous crystals ; also gummite, and possibly uraninite and uranotil. The uraninite is a cubo-octahedron, as yet in its matrix, but its form and its associations indicate its identity. These minerals are from the pegmatite veins in the gneiss near Fort George.

MR. HIDDEN read an article from a North Carolina paper, *The Landmark*, relating to the mining of zircon. Mr. Hidden and Mr. M. H. Mallory, of New York, had contracted to deliver 50,000 pounds of that mineral. Work was commenced in October last upon the Freeman and Jones lands on Green river, Henderson County, and at the present date the delivery was almost completed. The mining operation was similar to gold washing,

with "rockers," and at times over one hundred men were employed.

PROF. J. S. NEWBERRY read, by title, a paper

ON THE STRUCTURE AND ZOOLOGICAL RELATION OF THE PLACODERM FISHES.

(Published in the Annals, Vol. IV.)

DR. L. H. LAUDY exhibited and described a new and simple form of projecting lantern, and the several kinds of jets and illuminants employed. Some discussion followed by Dr. Bolton, Prof. Stevens, and Dr. Laudy, regarding the use of zirconia pencils in place of lime for the oxy-hydrogen light. The lantern was then used in illustrating the subsequent paper by Prof. Stevens.

PROF. W. LE CONTE STEVENS read a paper on

THE QUALITY OF MUSICAL SOUNDS,

(Illustrated with lantern views.)

(Abstract.)

The elements of a musical sound are pitch, loudness, and quality.

The determination of pitch as an index of rate of periodic motion dates back as far as the time of Galileo, whose method was naturally crude, in comparison with those of to-day. By means of the siren, devised by Cagniard de la Tour, and subsequently greatly improved by Helmholtz, and also by other methods yet more refined, pitch is quite distinctly measurable, and its determination is included among the oft-repeated operations of exact science.

Loudness is appreciable only through sensation, and no means for its exact measurement have been thus far devised. It may be regarded as at least a function of the energy of vibration, which in turn is proportional to the square of the amplitude of swing; but this is not a measure of the intensity of the nerve excitement which involves the sensation of loudness. If an artificial membrane be substituted for the ear, the variations of energy imparted to it, and manifested to the ear as variations of loudness, may be made visible and roughly measured by the method of manometric flames. (By means of appropriate lantern pictures, the construction and use of the manometric capsule was here shown, and flame images analyzed by the speaker.)

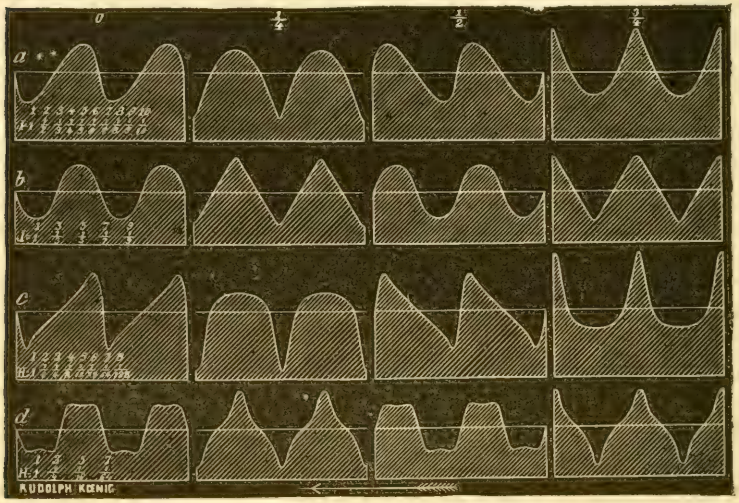
For the investigation of quality we need a method of representing musical sounds graphically before a path of research is opened. (The speaker then gave illustrations of the application of the graphic method, analyzing each case, and dwelling more particularly on Koenig's mode of compounding the parallel vibrations of two forks.)

Assume a compound musical sound made up of six components whose wave lengths form the series 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$. Draw all their sinusoids on the same axis, and compound these into a single curve, remembering that each loop with its convexity upward represents a momentary slight increase of intensity, and each with its convexity downward a momentary slight decrease of intensity. Then, as each compound wave strikes the ear, there are six subordinate impressions along with the general impression of a push and a pull on the auditory medium. These occur in a definite order, and the groups are repeated periodically. The result is a characteristic sensation quite different from that which arises if the fundamental sound alone impresses the ear. The quality is more brilliant, while the fundamental pitch remains the same. It might be quite natural to assume, as was once commonly done, that quality must, in some way, depend on the form of the sound wave. It was reserved for Helmholtz to give to this idea a firm experimental basis, and to show that quality depends upon the number, orders, and relative intensities of the upper partial tones which accompany the fundamental. His demonstration was a verification of what had previously been only guessed; for, if we vary either the number, or the orders, or the relative intensities of these upper partials, and plot the resultant curves, the latter become changed in form with the change in quality.

But there is another way, independently of those just mentioned, in which the wave form may be varied. It is that of varying the mode of combination of the same set of components. The accompanying figure, due to Koenig, shows groups of sinusoids compounded together with variations of phase between the fundamental and the upper partials. In the group marked 0, all begin together at the same origin, and hence with perfect coincidence of phase. In that marked $\frac{1}{4}$, there is a difference in phase of a fourth of a wave length of the fundamental between this and its first upper partial. In those marked $\frac{1}{2}$ and $\frac{3}{4}$, respectively, this difference of phase is a half-wave length and three-fourths of a wave length of the fundamental, respectively. In figures *a* and *b*, the amplitudes form a harmonic series determined by the corresponding wave lengths, *a* including the full series, and *b* the odd components only. In figures *c* and *d*, the amplitudes form a decreasing geometrical series determined

by the corresponding wave lengths, *c* the full series, *d* the odd components. The variation in form is striking, and certainly affords ground for the suspicion that the perceived quality should vary. To determine this question experimentally is difficult, not only because it requires a trained ear to appreciate such differences in quality as may be imposed, but because in no ordinary musical instrument is there any provision for the indication of the mode in which harmonic components are combined.

This problem was first attacked by Helmholtz, and with negative results. He used the same apparatus that was employed in his masterly analysis of vowel sounds. (A picture of Helmholtz's apparatus was here shown, and his method of work was de-



Variation in wave form with change of phase.

scribed.) To secure variation of phase between any two components of a compound sound produced by a group of forks, he narrowed the aperture of one of the resonators, thus throwing it slightly out of tune and weakening the resonance. As the result of mathematical investigation, Helmholtz reached the conclusion that if the pitch of the resonator is depressed, the greatest velocity in periodic motion of the air at its mouth slightly precedes that of the fork, producing thus a difference of phase. Suppose the resonators of the forks which yield the upper partials to remain open, while that of the fork yielding the fundamental is partly closed, so as to lower the pitch of the re-

sonator; then the waves from this resonator gain part of a wave length on those of the other resonators, which still vibrate synchronously with their forks. To allow for diminution of intensity in the sound of the fundamental resonator, the others may be withdrawn slightly from their forks. Helmholtz failed to detect the slightest difference in quality as a consequence of this variation in phase. His conclusion, therefore, was that the "differences in musical quality of tone depend solely on the presence and strength of partial tones, and in no respect on the differences in phase under which these partial tones enter into composition." If this unexpected conclusion be wrong, then either there was some fault in the mathematical deduction from the theory of resonators, or the mere fact of throwing a resonator out of tune so alters the conditions as to mask completely the change of quality that might otherwise be rendered sensible. The first of these alternatives is not very probable, for Helmholtz's skill as a mathematician is unquestioned. The second may be substantiated if an independent method of experiment is devised, by which the effect of change of phase is actually made perceptible.

As early as 1868 M. Rudolph Koenig constructed a wave siren which he employed in his investigations on the beats producible by combination of sounds of known interval. This instrument was subsequently modified and improved, and was applied by its inventor to the investigation of musical quality. (Pictures were here shown of two forms of wave siren, including the one containing the latest improvements, and their mechanism was explained by the speaker.) The wave siren may be described briefly as an apparatus in which a blast of air is forced through a narrow cleft against the edge of a moving plate or disc on which a series of determinate wave forms have been cut. Each sinuosity, as it passes the cleft, interrupts the egress of air, so that a series of compound pulses are propagated, whose grouping is determined by the form of the curved edge. The pitch is determined by the wave length cut in the metal, through either the convex surface of a cylinder which rotates on its axis or the edge of a disc which rotates about its centre. A number of such wave forms, each with its own wind-cleft, may be operated at the same time, with the same speed, and with the same pressure of air at each cleft. They may be arranged to either coincide or differ in phase to any required extent. In 1881 Koenig published the result of his experiments with this instrument, which, for the specific object he had in view, is far more satisfactory than that employed by Helmholtz. His conclusions may be expressed as follows (*Quelques Expériences d'Acoustique*, p. 242):—

"The complex sound obtained by the composition of a series of harmonics, of even as well as of odd orders, quite independently of their relative intensity, has always its maximum of strength and its greatest acuteness of quality for a difference of phase of a fourth of a wave length; the minimum of strength and the softest quality for a difference of phase of three-fourths of a wave length; the sounds corresponding to differences of phase zero and a half wave length lie between these two extremes in regard to both intensity and quality.

"The composition of a series of harmonics, taken in the order of the odd numbers, gives the same sound for differences of phase one-fourth and three-fourths, and also the same sound for differences zero and one-half; but in the first case the sound is stronger and more brilliant than in the second.

"If, then, quality depends indeed principally on the number and relative intensity of the harmonics into which it can be decomposed, the influence of the difference of phase of these harmonics is not so small that it can properly be neglected. It may be said that if changes in the number and relative intensity of the harmonics produce differences of quality such as are observed in instruments belonging to different families, or such as the human voice shows in the different vowels, the changes due to difference of phase between the same harmonics are yet capable of producing differences of quality at least as sensible as those which are noticeable in instruments of the same kind, or in the same vowels sung by different voices."

These conclusions expressed by M. Koenig have not yet received the general credit to which they are entitled. The cause of this is found partly in the overmastering authority of Helmholtz's splendid researches, which preceded Koenig's investigations on this topic, and partly in the fact that but few persons have had the opportunity personally to test the subject experimentally. The present writer, while spending a few weeks in Paris during the last summer (1887), enjoyed the privilege of using the wave siren in company with M. Koenig, and with satisfactory results. He noticed a distinct change of quality with change of phase. The chief object of the present paper is to add his confirmation to the conclusion reached by M. Koenig, and to call attention to what is due an acoustician whose mechanical skill in the construction of apparatus is more than equalled by his originality, care, and patience in investigation.

May 28, 1888.

STATED MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

A large audience present in the West Lecture Room of the Library Building, Columbia College.

The fourth lecture of the Popular Lecture Course was delivered by MR. FRED. H. CHAPIN on

ICE AND ROCK SCENERY IN THE FRONT RANGE, COLORADO.

(Illustrated with lantern views.)

June 4, 1888.

REGULAR BUSINESS MEETING.

The President, PROF. J. S. NEWBERRY, in the chair.

Forty-seven persons present.

The Report of the Council made the following recommendations:

I. The payment of certain bills.

II. The appropriation of $500 to pay for the printing of Annals and Transactions now in hand.

III. The acceptance of the resignations of Charles S. Bull and Mrs. J. C. Croly.

The election as Resident Members of

E. A. GOODRIDGE, M.D.,
FRANK ROOSEVELT,
W. D. SCHOONMAKER.

The items of the report were severally adopted, and the candidates were elected by formal ballot.

PROF. O. P. HUBBARD read, by title, the following paper:

ON THE SEA ANEMONES OF SWALLOW HOUSE OR CAVE IN THE ROCKS AT NAHANT, NEAR LYNN, MASS., BY REV. MANASSEH CUTLER.

The great interest attached to this account arises from the fact that it is believed to be a record of the earliest, if not the only study, of this class of animals in America in the last century, and has only now, after the lapse of ninety-seven years, been brought from its hiding place to the knowledge of the public, and is wholly unknown to our most eminent scholars in this department of Natural History.

Mr. Cutler was elected a member of the American Academy of Arts and Sciences at its first business meeting, January 31st, 1791; and as our New York Academy is one of the oldest in the United States, it is that well the paper should appear in its Transactions, and thus become known to science.

This account of the Sea-Anemone is found among Dr. Cutler's papers, p. 468, VI.[1]

"The Sea-Anemones are a most singular species of animals, approaching nearly, if not nearest, to the connecting link between the animate and inanimate creation. We have had no account of the discovery of the Sea-Anemone on American shores until the year 1791.

In the month of June, 7th, Dr. Cutler, with the Rev. Dr. Prime of Salem, in company with several other gentlemen, visited the cavern in the rocks on the southern side of Nahant, in Lynn, called the Swallow House, for the purpose of searching for them. At the bottom of the cavern, after the tide had receded, they found great numbers of different sizes and a great variety of colors.

The general form of this singular animal, when moderately contracted, is nearly like that of a truncated cone with its base adhering to the rocks; but it has the power of assuming a variety of shapes. The position in which some of them appeared resembled a full-blown anemone; others approached nearer the flower of a large rose or poppy, and some were extended in an oblique direction, with the leaves so much contracted as to exhibit only their margin in the form of a fringe.

When the arms or leaves of the larger ones were fully dis-

[1] Life of Rev. Manasseh Cutler, LL.D., by his grandchildren. 2 vols. Cincinnati, 1880. Robt. Clarke & Co.

played they measured 5 and 6 inches in circumference, exhibiting a great variety and brilliancy of colors. Some were of the purest white; some of the most delicate flesh color; others tinged with purple, green and violet, and still others shaded and variegated with the finest brown or black. On touching the arms or leaves they instantly contract. By expanding and contracting the leaves they collect and convey food to their mouths, which are placed in the centre of the blossom.

On offering them bits of muscles [1] they directly seized them with their arms, conducted them to their mouths and swallowed them.

If pieces of shells adhered to the muscles, or if small muscles were given them, the shells were afterward discharged by the mouth.

The Sea-Anemone is said to be viviparous. It has also the power of reproduction. If the arms are clipped off they will bud and grow to the usual size. And the Abbe Dicquemare has shown by a course of experiments that, like polype, it may be multiplied by shreds clipped from the animal. These Anemones have a progressive motion, moving but extremely slow. Mr. Joseph Barrel, of Charlestown, who, with several other gentlemen, was there at the same time, carried home a pebble on which an Anemone had attached itself, and preserved it several months in sea-water. It disengaged itself from the stone and moved about the vessel in which he had placed it.

It has been classed among the zoophytes."

The Corresponding Secretary, Dr. A. A. Julien, reported that letters accepting honorary membership had been recently received from the following persons:

Prof. Alexander Agassiz,
Prof. S. P. Langley,
Dr. Joseph Leidy,
Prof. Dr. G. Meneghini,
Prof. Louis Pasteur,
Sir Henry Roscoe,
Prof. H. F. Rosenbusch,
Prof. John Tyndall.

And in acceptance of corresponding membership from

Cavre. Sebastiano Fenzi,

[1] The old spelling of *mussel* (Ed.).

PROF. F. A. GOOCH,
LA PRINCESSE HÉLÉNE KOLTZOFF-MASSALSKY,
REV. THOMAS MORONG,
MR. T. MELLARD READE.

The Librarian, DR. N. L. BRITTON, read the list of Accessions to the Library for May.

PROF. O. P. HUBBARD showed a milk tooth of a *Mastodon*, from the phosphate beds of Beaufort, S. C. The base of the tooth, without projections, is six and one-half by three inches, The crown is three inches high, with four ridges, each ridge with two eminences, the inner ones notched. The two anterior or smaller pair are covered by an adhering oyster shell.

The PRESIDENT remarked upon the distribution and extinction of the animal, and the occurrence of the fossils. He had information of a tusk, in Indiana, which is ten feet long, and weighs one hundred and eighty pounds.

The two following papers were read by title :

NOTES ON THE SUBCARBONIFEROUS SERIES AT SEDALIA, MISSOURI.

BY F. A. SAMPSON.

Sedalia, Missouri, is near the boundary line of several geologic terrains, the Magnesian series appearing at the surface two miles south, and the Coal Measures a few miles west.

In the quarries close by the city, the Burlington series is only a few feet in thickness, and rests upon the Chouteau limestones of the Missouri Geological Survey. These limestones are here of a gray or dove-colored stone, 144 feet in thickness, as shown in an Artesian well boring of 1,600 feet.

In the neighborhood are some pockets of coal, which have been deposited in depressions on the Chouteau limestones.

The Chouteau limestones are referred by Prof. G. C. Swallow ("Missouri Geol. Rep.," 1855, p. 101) to the Chemung series, and by Prof. James Hall ("Geol. Surv. Iowa," 1858, p. 103) to the same series; Prof. A. H. Worthen ("Geol. Surv. Illinois," Vol. 1, 1866, p. 109) refers this series to the Kinderhook group, which occupies in geological time a similar place to that of the Waverly series of the Ohio Geological Survey.

Dr. C. A. White ("U. S. Geol. Surv. Terr.," 12th Ann. Rep., 1878, p. 159) remarks with regard to this series, and its fossil

corals. The discovery of four new forms of corals in the Kinderhook "is a matter of much interest. This interest is also increased by the fact that they are all of types which are unusual in at least American Carboniferous strata; and although there is no *à priori* reason why the presence of these types might not be expected in Carboniferous strata, according to our present knowledge such a group of corals is not without a certain Devonian facies."

The author describes the following new species from the Chouteau limestones of Sedalia. *Zaphrentis calceola*, White and Whitfield; *Chonophyllum Sedaliense*, White; *Michilinia (?)placenta*, White; *M. expansa*, White, and *Lithostrotion microstylum*, White.

In the "Trans. St. Louis Acad. Sci.," Vol. 4, No. 3, Dr. G. Hambach describes *Pentremites Sampsoni* from the Chouteau limestone and *Codonites campanulatus*, Lower Burlington series of Sedalia. Descriptions of these species are also included in the "Bull. Sedalia Nat. Hist. Soc.," 1885, p. 29.

Amongst the Palæozoic Crustacea collected at Sedalia we have the new species described in the following paper: *Phillipsia Sampsoni* and *Griffithides (?) Sedaliensis* from the Chouteau limestone, and others of a new species of the genus *Proetus;* one of these consists of a detached pygidium with 9 axial rings and 7 side ribs, bordered by a prominent limb, the axis being marked with three rows of nodes; another specimen is entire and was procured from a chert nodule of the Chouteau limestone. The condition of these specimens will not permit of a detailed description, and we therefore only indicate the appearance of these fossils.

In the overlying Burlington series, we have so far only one specimen of *Phillipsia tuberculata*, Meek and Worthen. The coal measures only furnish small worn fragments of *Chætetes milleporaceus*, Troost, but not in place.

Both the Burlington and Chouteau beds here include layers of chert, and the latter also chert nodules in the limestone beds.

DESCRIPTION OF TWO NEW SPECIES OF CARBONIFEROUS TRILOBITES.

By A. W. Vogdes.

PHILLIPSIA SAMPSONI (n. s.) Vogdes.

Description.—General form, oval. Cephalic shield parabolic, obtusely pointed in front, slightly broader than long. Glabella prominent, convex and but slightly tumid; almost twice as long as broad, acutely rounded in front; basal lobes distinct, and

separated from the glabella by rather deep furrows. The glabella has three short lateral furrows on each side, the middle one being opposite the anterior end of the palpebral lobe. Eyes large, reniform; occipital ring distinctly marked, somewhat triangular in form, and separated from the glabella by a broad and well-defined occipital furrow; surface of the glabella coarsely granulated.

Fixed cheeks, narrow behind, forming a palpebral lobe about each eye. Limb smooth on its upper surface, but striated along its outer margin. The movable cheeks probably terminate in cheek spines, but this not indicated in the rolled specimen now before us.

Thorax with nine segments; the axis is strongly marked by well-defined dorsal furrows, and elevated above the plane of the pleuræ; width greater than the length of the pleuræ. Pleuræ grooved and faceted. Surface of test smooth. Pygidium semi-elliptic, axis very prominent, and forming less than one-third

the width of the anterior margin, which is gently arched. Axial rings seven. The lateral lobes are marked with six ribs on each side, which bend rather gently downward and decrease in size as they approach the posterior margin of the pygidium. Surface smooth.

Dimensions.—Total length, 20 mm.; length of glabella, 5 mm.; width of same, 3½ to 4 mm.; width of occipital ring, 1½ mm.; length of thorax, 8 mm.; length of pygidium, 5½ mm.; width of same, 9 mm.

Geological position and locality.—Waverly series, Sedalia, Missouri, from the cabinet of F. A. Sampson, Sedalia, Mo.

This species of *Phillipsia* can readily be distinguished from all others by its limited number of axial rings in the pygidium.

GRIFFITHIDES (?) SEDALIENSIS (n.s.), Vogdes.

Description.—Pygidium semi-elliptic; axis broad, conical, and prominent, occupying a little less than one-third of the width of the pygidium on its anterior border, which is arched. Axial rings 12. Lateral lobes marked with 11 ribs. The test is covered with a regular series of tubercles, which run through

the centre of the ribs and axial rings. Limb of pygidium narrow and apparently smooth.

Geological position and locality.—Waverly series, Sedalia, Mo., cabinet of F. A. Sampson.

Affinities and differences.—This small pygidium approaches in general *Griffithides seminiferus*, Phillips, from the English carboniferous limestone of Yorkshire, which has twelve axial rings and nine side ribs; the surface being ornamented by a single row of tubercles along the centre of each axial ring and side rib; eight to ten on axis and about eight on each side rib. The American species is much smaller in size, and has a greater number of tubercles, with an arched anterior margin instead of the straight one usually found on Phillips' species. Compared with American tuberculated forms, this species differs from *Phillipsia tuberculata*, Meek and Worthen, first by having a less number of axial rings (twelve instead of sixteen or seventeen), and also varies in the number of side ribs (ten instead of fourteen). The surface of *P. tuberculata* is marked with six small tubercles, arranged on the axial rings so as to form six rows, and the side lobes are each ornamented by a row of tubercles along the ribs, varying from twelve to two, according to their length.

On *Griffithides* (?) *Sedaliensis* the test of the pygidium is ornamented by a row of tubercles running across the axial rings, varying from twelve to three according to the length of the rings. On the side ribs the number of tubercles varies, according to length, from eleven to three. The space immediately in rear of the axis is also ornamented in the same manner. The pygidium of *Phillipsia insignis*, Winchell, has twelve to fourteen axial rings, each bearing six small tubercles, the whole of which are arranged in six longitudinal rows, and ten side ribs. From this species our specimen can also be readily distinguished by its surface markings.

Compared with the pygidium of *Phillipsia trinucleata*. Herrick (Bull. Sc. Lab. Denison Univ., Vol. II., 1887, p. 64), our species has a less number of axial rings, twelve instead of seventeen to nineteen, and a like variation in the number of ribs. The marginal limb of this species is broad and longitudinally striated, whereas our species has a narrow limb, apparently smooth.

This last characteristic has prevented us from comparisons under the genus *Brachymetopus* appearing in the Waverly group.

If *Griffithides Sedaliensis* is a true *Griffithides* (as its affinities with *G. seminiferus* indicate), we have in these Sedalia beds a very early appearance of a genus which heretofore was only known to the Keokuk, Chester, and Upper Coal Measures. We

therefore hope that our friends in Sedalia will clear up its doubtful affinities; and also the range of this genus in Carboniferous rocks.

Mr. W. E. Hidden reported the discovery, within the city, by Mr. William Niven, of fine green and brown tourmalines. The green ones are very clear, and although minute, would cut into gems. With them occurred fine pyrite and pyrrhotite crystals.

Mr. Hidden stated that he had lately received from his mines in Alexander County, North Carolina, a number of emeralds, which are clear and of fine color. From one six gems have already been cut, of a probable value of $500. These were found incidentally and before the regular mining for the season had commenced.

Mr. George F. Kunz exhibited specimens of ruby corundum, from near Atlanta, Georgia. A mass of three hundred and fifty pounds was found on the surface of the ground.

Also gold-bearing quartz from near Parimaribo, Dutch Guiana. This occurs four miles from the coast, to which it is carried by the natives.

Rhodonite, from near Cummington, Mass., was shown. Formerly it was found in boulders, but is now found in place.

He also exhibited phenacite, from near Stowe, Maine. It was found in a pocket, associated with topaz and smoky quartz, and also detached. This is the first discovery of this mineral in the United States, outside of Colorado. The crystals are lenticular, thin, and resemble those from Florissant, Colorado. Large cavities abound in the crystals, which might have contained a fluid.

Mr. Kunz gave the following particulars relating to the diamond, from Georgia, exhibited April 16th.

In April, 1887, Mr. Lewis M. Parker, a tenant on the farm of Daniel Light, situated three-quarters of a mile northwest of Marrow Station, and thirteen miles south of Atlanta, found a diamond on the farm. The stone afterwards came into possession of Mr. W. W. Scott, of Atlanta, who sent it to me for examination. It proved to be an octahedral crystal weighing $4\frac{1}{12}$

carats (828 milligrams), $\frac{2}{3}$ of an inch long and $\frac{1}{4}$ of an inch wide, and measuring $9 \times 10 \times 7$ mm. It is slightly yellow, has one small black inclusion, and would afford a stone of from $1\frac{1}{2}$ to 2 carats' weight. The specific gravity I found to be 3.527. The surface of the stone is curiously marked with long shallow pittings.

Mr. L. O. Stevens, of Atlanta, Ga., has communicated to me that a colored man called on him during the past year with a two-carat diamond, defective and of very poor color, which he had found in his garden within a few miles of Atlanta. The finder, Mr. Stevens says, has shown no desire to sell or loan the stone.

In behalf of the Committee appointed at a former meeting, PROF. D. S. MARTIN read a memorial notice[1] of

Dr. Joseph B. Holder.

Dr. Joseph Barrett Holder was born in Lynn, Mass., October 26th, 1824. He was descended, on his mother's side, from the Barretts, a well-known English family during the time of Henry VIII., while the Holders were among the early Friends or Quakers in this country.

Dr. Holder's immediate ancestor in America was Christopher Holder, who came over, in the ship *Woodhouse*, in 1657. As a Quaker, he came to this country to escape religious persecution. Landing in New York, he went to Boston, where he was thrown into jail for avowing himself a Quaker or Friend. The different branches of the family settled in and about Boston; and Dr. Holder's great-great-grandfather built a house in Lynn in 1700, at the corner of Nahant and Sagamore streets. It is still in use, though moved in 1855. Here Richard Holder, grandfather of Dr. Holder, was born in 1757, and his father, Aaron Holder, in 1797. The latter carried on until his death the drug business; the house of Holder & Co. is still flourishing in Lynn.

The subject of this notice was educated at the Harvard Medi-

[1] In place of the notice read, the following more extended sketch is here inserted.

cal School, became distinguished for his skill as a surgeon, and was demonstrator of anatomy under Oliver Wendell Holmes. In 1846 he began the practice of medicine in Swampscott, Mass., and later he moved to Lynn and became the city physician.

From his youth he had been an ardent lover of nature, and did all in his power to encourage a love of the study among the people. He founded the Lynn Natural History Society, and added much to its collections. He made a trip over New York State before the time of railroads, collecting specimens for its cabinet, and studying the fauna, flora, geology, etc. He was an ardent botanist and made probably the first list of plants of Essex County, Mass. He left copious notes of their habits, time of appearing, etc., showing that there was hardly a foot of this locality that was not intimately known to him. He made fine drawings of the plants, often in color, and kept what might be called a diary of plant-life. In 1844, he made a catalogue of the birds of Lynn and vicinity, which appeared as Bulletin No. 1 of the publications of the Lynn Nat. History Society. This led to his meeting the late Prof. S. F. Baird, and the formation of a lifelong friendship. Dr. Holder early met Prof. Agassiz, and often joined him at his home in Nahant, and for some years made many investigations, dredging and collecting, particularly with his intimate friend, Prof. William Stimpson.

In 1859, he was offered an appointment as surgeon in the U. S. Engineer Department, at Tortugas, Fla., which he accepted. This step was taken partly at the instigation of Profs. Baird and Agassiz, and it gave him an opportunity to enter more fully into the studies of his choice.

Arriving at Fort Jefferson, he began experimental studies, and collected hundreds of new and hitherto undescribed species in almost every branch of the animal (marine) kingdom. These were chiefly sent to the Smithsonian Institution and to Harvard College, while many other colleges received specimens of his collecting. To study better the habits of animals and the growth of certain corals, he had an aquarium built out into the water, and here carried on a systematic study of the growth of corals, watching them from day to day.

The ideas prevailing then concerning coral-growth were more

or less incorrect. Dr. Holder placed bricks in the water and kept them under daily observation, and found that a specimen of *Mœandrina convexa* doubled its diameter in one year. This test-specimen is in the collection of the American Museum of Natural History, New York, and is figured in Holder's "Elements of Zoology," page 26, Fig. 24. Experiments with branching and other corals showed the rate of growth to be much more rapid than had been generally supposed, and many valuable notes upon the growth of coral reefs are recorded in his works. Dr. Holder made interesting experiments with the Physalia, its poison, its parasitic or attendant fishes, the Holothuria and Fierasper, etc., and sent specimens north of every animal found upon the reef.

He was particularly interested in the flight of birds, and had interesting correspondence with Darwin upon the subject. This question Dr. Holder reviewed in his last ornithological paper, on the flight of birds, read before the New York Academy of Sciences, Dec. 19th, 1887.

When the war broke out, Dr. Holder became acting assistant-surgeon in the regular army, and served throughout the war. He also was health officer of the post, and had the medical charge of the great prison at Dry Tortugas when it was crowded with prisoners. Through his personal efforts, funds were raised to alleviate the sufferings of the prisoners, who were dying of scurvy; and only through his prudence and experience was the prison kept from the horrors of epidemics. When he was ordered away, and an inexperienced surgeon took his place, yellow fever carried off almost the entire post.

Dr. Holder was a prolific writer, and, while he contributed to many scientific publications, he was always impressed with the value of creating an interest in nature among the masses. He believed that a knowledge of nature and her works would exert a refining and cultivating influence; and many of his writings tended in this direction. These were on scientific subjects popularly treated; his idea being to divest them of technicality, so that an interest would be aroused in the study, even among the most ignorant. In this he was eminently successful. He contributed, in 1867–8, an elaborate series of articles on the Florida

reef to *Harper's Magazine,* which, running through six months, described his life in the great prison and the flora and the fauna of the reef. He contributed special articles to the various scientific publications of the day, reviewed and prepared scientific works for the press, and for many years contributed articles to the New York *Evening Post* on the Museum of Natural History in this city. He was particularly interested in the study of the cetacea or whales, and one of the Bulletins of the Amer. Mus. Nat. Hist., N. Y., is devoted to his discussion of the Atlantic Right Whales; while many semi-scientific papers were published on this subject in the papers of the day. He was also interested in archæology, and contributed to the *Century Magazine* a valuable illustrated paper on "The Stone Collars of Porto Rico, etc.," and many papers on allied subjects to other periodicals. At the time of his death, he was preparing an elaborate work on an archæological subject.

Dr. Holder was joint author with the Rev. J. G. Wood of one of the finest popular works on natural history ever published, entitled, "The Living World." It comprised an entire review of the animal kingdom. Dr. Holder provided the matter relating to the American fauna, and edited the work. He also added the account of the American fauna to Sir John Richardson's work, "The Museum of Natural History," this portion of which was later published separately as the "American Fauna." He was also joint author with his son of "Elements of Zoology," a textbook in the Appleton Science Series.

Dr. Holder occasionally lectured on natural history, and was instrumental in forming various societies of natural history. He was ever ready to assist young naturalists, and stimulate in them a love for nature and reverence for the Power that governs it.

In 1868, Dr. Holder was ordered to Fort Monroe, Va. In 1870 he resigned to join Prof. A. S. Bickmore in the establishment of the Museum of Natural History, Central Park, New York, and for years that gentleman and himself carried on this great work, and cared for the collections almost unassisted—a labor that few not acquainted with the subject can appreciate. Dr. Holder was at first assistant superintendent, and during the past few years curator, of the Department of Invertebrate

Zoology. The work was a labor of love; and all his interests were centered in the great institution which he had seen grow from nothing.

Dr. Holder was a member of a number of societies, among them the Lynn Natural History Society, the Society of Eastern Naturalists, the American Ornithologists' Union, the Society of Psychological Research, patron of the Metropolitan Museum of Art, New York City, Fellow of the New York Academy of Sciences, etc. Dr. Holder was a member of the Society of Orthodox Friends; and of his career it can be said by those who knew him best, that few have lived a life of such absolute purity and uprightness, both in thought and action.

Notice was given of the recent death of PROF. R. D. IRVING, and remarks upon his life and work were made by the PRESIDENT.

MISS FANNY R. M. HITCHCOCK read a paper entitled,

NOTES ON THE LARVÆ OF AMBLYSTOMA.

The following notes were made chiefly with reference to the "balancers" of Amblystoma larvæ.

The eggs and larvæ examined agreed in all respects with the description and figures of Am. punctatum and were probably the same species.

The development of Am. punctatum was described by Mr. Samuel F. Clarke[1] in 1880, but I have not, as yet, been able to consult his paper, and have depended on the brief abstract of it given by Balfour,[2] which is here quoted:

"The larva of Am. punctatum is provided with two very long processes, like the suctorial processes in Triton, placed on the throat in front of the external gills. They are used to support the larva when it sinks to the bottom, and have been called by Clarke balancers. On the development of the limbs, these processes drop off."

In such of the Urodela as have been studied in the larval stages, processes similar to these are present.

Suctorial discs, which are regarded as the homologues of these processes, are found in the majority of Anura larvæ. Parker

[1] S. F. Clarke, "Development of Amblystoma punctatum," Part I. External. Studies from the Biological Laboratory of the Johns Hopkins University. No. II., 1880.

[2] Balfour, "Comparative Embryology," vol. II., p. 117.

states that they are absent in the Aglossa,[1] but I think they may possibly be represented by the long tentacles of Dactylethra.

In the larvæ which I had under observation, the balancers made their appearance at the same time as the external gills, as lateral buds on the head, similar to those representing the gills, and some distance in front of them.

From the first, the development of the "balancers" was strikingly like that of the gills, and at the time of hatching, the principal difference in appearance was due to the tips of the gills being slightly bifurcated; this being the beginning of the lateral branching.

The resemblance alluded to was so striking that I placed the larvæ under the microscope, to see if any trace of circulation could be found in the "balancers."

Save that it is somewhat intermittent, the circulation is as perfect in the "balancers" as in the external gills, the blood-corpuscles passing outward by an artery on the posterior aspect of the "balancer" and returning by one on the anterior aspect. When re-entering the body, the corpuscles appear to flow forward and downward in front of the mandibular arch. On the sixth day after hatching, the circulation was still observable, though very slow and irregular. On the eighth day I could no longer detect it, and on the tenth the "balancers" had disappeared.

That the "balancers" of Amblystoma are true external branchiæ can scarcely be considered doubtful, and the suctorial processes of other Urodela, together with the sucking discs of the Anura, must be placed in the same category, and regarded as representing former respiratory organs, which have become functionally so modified as to leave but little trace of their original nature.

An interesting question arises, as to whether the modification of the external gills in the amphibia can be regarded as affording any explanation of the preoral suctorial discs of the larvæ of Lepidosteus and Acipenser.

Concerning these, Balfour makes the following remarks.[2] In the Sturgeon (Acipenser): "In front of the mouth two pairs of papillæ grow out, which appear to be of the same nature as the papillæ on the suctorial disc of Lepidosteus. They are very short . . . but soon grow in length, and it is probable that they become the barbels, since they occupy a precisely similar position."

In a note on the same page he says: "If these identifications

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[1] See Balfour, loc. cit., pp. 110 and 115.
[2] Balfour, "Comp. Emb.," p. 89.

are correct, then the barbels of fishes must be phylogenetically derived from the papillæ of a suctorial disc adjoining the mouth."

Of Lepidosteus, he says :[1] "On the ventral surface of the front of the head there is a disc which is beset with a number of processes, formed as thickenings of the epiblast. As shown by Agassiz, these eventually become short suctorial papillæ." "The young fish on hatching immediately uses its suctorial disc to attach itself to the side of the vessel in which it was placed."[2]

Describing the suctorial discs of the Anura, he says : "They are probably remnants of the same primitive organs as the sucking disc of Lepidosteus."[3]

If the homologies suggested in these extracts are correct, we have in the preoral processes just described, representatives of external branchiæ, and we have them also in the barbels of fishes and of the larvæ of Dactylethra.[4]

The labial cartilages may probably represent the remains of an extra-branchial system connected with them.

The cilia on the gills, as on the body, are arranged in raised clusters, which bear a close resemblance to, and are bdoutless homologous with, the sensory organs of the lateral line. Special lines of these organs are present, as is well known, in amphibian larvæ, and one line connects the bases of the fore and hind limbs.

Gegenbaur considers that the limbs are derived from branchial arches and rays—a view which was held for a while by Dr. Anton Dohrn. When, however, it was found that the paired fins "arose as special developments of a continuous ridge on each side, precisely like the ridges of epiblast which form the rudiments of the unpaired fins,"[5] a fatal objection was supposed to be offered to Gegenbaur's view, and the theory now most in favor seems to be, that the limbs are derived from continuous lateral fin-folds.

If, however, we regard the limbs as derived from the external branchiæ and the extra-branchial system, the lateral fold could represent a series of coalesced external gills, which might be modified throughout its whole extent, or, it might be modified in

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[1] Ibid., p. 95.
[2] Ibid., p. 98.
[3] Ibid., p. 110.
[4] If a system of preoral arches existed—and I hope in another place to give some evidence of a different nature from that given above, in favor of such a view—any effort to ascertain the number of original cranial segments can scarcely be crowned with success.
[5] Balfour, "Elasmobranch Fishes," p. 101.

parts only—the unmodified parts disappearing. The attachment of external gills to the pectoral arch of Lepidosiren is very significant in this connection. The branching of the gills is noteworthy here. In most of the larvæ I had the branching was unilateral, but in a few there were traces of bilateral branching. In Salamandra atra, as figured by Wiedersheim,[1] the gills are very long, and the bilateral branching is perfect, giving them the appearance of plumes. From such a gill as this the derivation of the Dipnoan type of limb would be very simple, while by the suppression (or non-development) of the branches on one side there would be a uniserial type from which other forms could be derived.

In my specimen of amblystoma, the branches appeared first at the distal extremity of the gills, and developed in regular succession toward the proximal. The limbs appeared as lateral buds close behind the gills, and had the circulation well established by the fourth day after hatching. By the fifth day the limb was elongated, and a slight bifurcation of the distal extremity was noticeable, which was very marked by the seventh day, and the first and second digits were well separated. So far as my observations on the living specimen are concerned, they go to show that these digits are formed *before* there is any trace of differentiation of the humerus, radius, or ulna.

If the derivation of the limbs suggested here is admissible, the presence of a lateral fold in the Cyclostomata larvæ does not necessarily imply that this group formerly possessed lateral fins, as Prof. Dohrn supposes, but might only indicate the former possession of external gills, which extended backward through the body segments. The branchial clefts were formerly far more numerous than now, as is shown by Amphioxus, and I think it probable that, in the earliest forms, they extended the entire length of the animal.[2] Some of the suggestions offered here I hope, in a later paper, to develop more fully.

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[1] Wiedersheim, "Lehrbuch der Vergl. Anat.," p. 611, f. 475, C.

[2] Prof. John A. Ryder has kindly allowed me to state that he find in the embryos of the shad rudimentary gill clefts, posterior to those which develop in the adult. Mr. Ryder has also called attention to some facts which do not seem quite in accord with the lateral fin theory. See "Annual Report Commissioner of Fisheries," 1884, pp 1,044–1,046.

Miss Fanny R. M. Hitchcock read a paper entitled:

FURTHER NOTES ON THE OSTEOLOGY OF THE SHAD (ALOSA SAPIDISSIMA).

(Published in the Annals, Vol. IV., No. 7.)

Mr. H. Hensoldt gave an address upon

THE ULTIMATE COMPOSITION OF MATTER.

Adjourned to the first Monday evening in October.

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